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Taxonomic and Biological Investigations in the Genus Megastigmus

With Particular Reference to the Taxonomy of the Nearctic Species (Hymenoptera: Chalcidoidea; Callimomidae) [1, 2]

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1 The major portion of a thesis submitted to the faculty of the Graduate School, University of Minnesota, in partial fulfillment of the requirements for the degree of Doctor of Philosophy, 1942.

2 Paper No. 2299, Scientific Journal Series, Minnesota Agricultural Experiment Station, St. Paul 1, Minnesota.

Introduction

The first and only revision of the Nearctic species of the genus *Megastigmus*, of the chalcidoid family Callimomidae, was published in 1913 by C. R. Crosby. This work was based on a limited amount of material and therefore its scope was necessarily restricted. Yet, for nearly three decades it has remained virtually the only source of aid in identifying the North American species of this genus. The new species added since 1913, together with the increasing need for a better understanding of specific limitations throughout the genus, have incited this second revision of the Nearctic species. The scope of this investigation is not, however, restricted to the Nearctic region but contains an assemblage of information having to do with the genus as a whole.

The present undertaking is the result of a study begun in 1938. It is divided into two major parts: Part I deals solely with the taxonomy of the Nearctic species and includes a catalog of the species of Megastigminae; Part II contains both original and compiled biological information. The second part is therefore intended to constitute, in brief, all that is known of the biology of *Megastigmus*.

The phylogeny of *Megastigmus* and related genera of the subfamily Megastigminae is reserved for a future treatment, which should be undertaken only after the species comprising these groups are thoroughly and completely understood.

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Acknowledgment of indebtedness is made to the following: Dr. Osmond P. Breland, of the University of Texas, Austin, who offered valuable suggestions and materials; Dr. Henry Dietrich, of Cornell University, Ithaca, for supplying much information concerning the Crosby material, and for other favors and opinions freely rendered; and Dr. S. Marcovitch, of the University of Tennessee, Knoxville, for information pertaining to the type series of *M. laricis* Marc., and for his generous donation of a portion of this series to the collection of the University of Minnesota. Others, in addition, have rendered much appreciated assistance, especially the following who made special efforts to obtain seed material for rearing purposes: Regional Foresters and members of their staffs, of the U. S. Forest Service, whose cooperation was procured through the offices of Dr. F. C. Craighead and Mr. L. W. Orr, of the Bureau of Entomology and Plant Quarantine, U. S. Department of Agriculture; Dr. R. W. Dawson, Dr. C. E. Mickel, Dr. H. D. Pratt, Mr. Philip Schroeder, Mr. H. L. Gunderson, and several graduate students in entomology, all of the University of Minnesota; and Mr. J. C. Bridwell, of Washington, D. C.

It is a pleasure to recognize the aid of Miss L. Mae Centerwall, of the Department of Agriculture Library, University of Minnesota, St. Paul; her persistent efforts to procure publications not available in the University libraries have made it feasible to review numerous papers that otherwise could not have been examined. Thanks are extended to Dr. Mykola Haydak, of the Division of Entomology and Economic Zoology, University of Minnesota, for his translations of several papers in Russian. Mr. Kan-Fan Chen, graduate student in entomology, University of Minnesota, kindly made known the contents of

the available Japanese literature pertaining to the subject, and the helpful assistance of Mr. H. L. Gunderson was had in translating the usable parts of some of the Norwegian papers.

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Part I.—Taxonomic Investigations in the Genus Megastigmus

Superfamily CHALCIDOIDEA

Family CALLIMOMIDAE

The subfamily Megastigminae, to which the genus *Megastigmus* belongs, is a division of the family Callimomidae. It may be separated from all related subfamilies by the characters given in the following key, which is as published by Crawford (1914) except for minor alterations, and the omission of the subfamily Pulvilligerinae.

KEY TO THE SUBFAMILIES OF CALLIMOMIDAE

1. Parapsidal furrows well developed and distinctly defined 2
   Parapsidal furrows not well defined; mesoscutum scarcely or indistinctly separated; female abdomen conically pointed, the ovipositor not exserted ..... ORMYRINAE
2. Hind tibia with a single calcarium; propodeum elongate ..... ERIMERINAE
   Hind tibia with two calcaria 3
3. Stigma greatly expanded ..... MEGASTIGMINAE
   Stigma not greatly expanded 4
4. Postmarginal vein present; antenna not densely pilose 5
   Postmarginal vein absent; antenna densely pilose ..... EUTANYCORMINAE
5. Mesepimeron incised on the posterior margin 6
   Mesepimeron not incised on the posterior margin, but more or less straight 7
6. Stigmal vein sessile or subsessile ..... CALLIMOMINAE
   Stigmal vein long ..... IDARNINAE
7. Hind femur noticeably swollen; tibia arcuate ..... PODAGRIONINAE
   Hind femur not noticeably swollen; tibia not arcuate ..... MONODONTOMERINAE

GENERA OF THE SUBFAMILY MEGASTIGMINAE

The subfamily Megastigminae is composed of relatively few genera. Walker (1833) first elevated *Megastigmus* to generic rank, and since that time most of the megastigmine species described have been placed in this genus with the exception of several described by Girault. *Megastigmus* Dalman, *Bootania* Dalla Torre, and *Odopoia* Walker formed the subfamily in Ashmead's (1904b) *Classification of the Chalcid Flies*. Four additional genera have been proposed since 1904, but the status of one of these (*Neomegastigmus* Girault) is doubtful.

Megastigmus itself has been divided into several subgenera by Girault (1915b). It should be indicated that the additions and changes proposed by Girault have concerned exclusively the species of the Oriental and Australian Regions. In his extensive treatment of *Megastigmus*, this author erected three new subgeneric groups which he apparently regarded as genera in some of his subsequent publications. These will be mentioned briefly. *Bootanomyia* Girault (Australia and Philippine Islands) is based on the body being partly or wholly metallic and frequently with thimble punctations; in this respect

it is similar to the European *M. dorsalis* (Fabr.). *Epimegastigmus* Girault (Australia) is differentiated from *Megastigmus* only on the basis of a median and usually a lateral grooved line on the scutellum "all more or less abbreviated caudad"; this is a variable character which is sometimes entirely absent in species assigned to this group. The author has examined only a single species of this supposedly distinct genus, *i.e., Epimegastigmus brevivalvus* Gir., and he is in agreement with the opinion of Mr. A. B. Gahan as published by Noble (1938a), namely, that this species can well be considered a genuine *Megastigmus*. Some of the Nearctic species may have a median grooved line on the scutellum, especially anteriorly, but this has been found to be an unreliable character. Regarding this Girault (1929) himself made the following statements: "The grooves on the scutellum first used by myself, unfortunately have been found to form one of those characters which is indeterminate — one can never be sure. Therefore *Epimegastigmus* and *Megastigmus* must be worked together." *Paramegastigmus* Girault (Australia) was proposed for species with a short petiolate abdomen, nearly "obsolete sutures," and a subsolid antennal club. The condition of the petiole and the character of the "sutures" would seem to be the only features by which one might possibly recognize such a group. In summarizing the above genera of Girault, *Epimegastigmus* is here regarded as being congeneric with *Megastigmus* (*sens. str.*); the validity of *Bootanomyia* and *Paramegastigmus* as good genera can only be questioned until further study is undertaken.

Neomegastigmus Girault (Australia), originally proposed as a genus, does not appear to possess any characters different from those universally included in the concept of *Megastigmus*. Girault stated: "This genus is like *Spilomepastigmus* Cameron but the mandibles tridentate, the antennae 13-jointed, the club distinctly 3-jointed; one large ring joint. Fore wings usually with a black spot appended from the stigmal vein. Scutellum simple, uniformly sculptured." It seems that one would be perfectly justified in including this genus in the synonymy of *Megastigmus* were it not for the confusion likely to result from such a procedure at this time. Because *Neomegastigmus*, like *Bootanomyia*, *Epimegastigmus* and *Paramegastigmus*, does not appear to be sufficiently distinct it is not included in the key to the genera of this subfamily. However, these Australian genera in question, except *Epimegastigmus*, are included in the catalog as valid categories until they can be given critical study. The lack of Australian material representing genotype species makes such a treatment virtually imperative in order to avoid additional confusion in the taxonomy of the group as a whole.

In 1905, Cameron erected the genus *Spilomegastigmus* for a single new species from Ceylon. In all probability this will prove to be a good genus, but the original description is too brief and lacks essential points; moreover, the figure accompanying the description is misleading with respect to wing venation. Neither genus nor species can be identified with certainty. It will be necessary to study the type and to redefine the genus. It is included in the generic key on the basis of the supposedly good characters given in the original description.

Epibootania Girault (Australia) appears to be distinct since the clypeus

has a very small median lobe or tooth on its ventral margin in place of the median incision that is characteristic of *Megastigmus*. At least this is true of *E. nonvitta* Gir., specimens of which have been examined. Also, in this species the scape seems to have a different shape and the mesopraescutum is normally concealed by the pronotum to a greater extent than in species of *Megastigmus*.

The remaining three genera are *Bootania* Dalla Torre (Bhutan, India), *Bootanelleus* Girault (Australia) and *Odopoia* Walker (Ceylon). These appear to be distinct and recognizable categories.

Tribal separation in the subfamily has not been attempted, principally because of the lack of clear definition of several of the genera already proposed. Before any such classification can be established successfully, careful study of all genotype species should be made in order to determine generic affinities with each other.

SYNOPSIS OF RECOGNIZED GENERA

Megastigmus Dalman, Kongl. Vet. Acad. Handl., p. 178, 1820.
Epibootania Girault, "New Hexapods," Priv. publ., 3 unnumb. pages, 1937; Rev. Ent., vol. 8, p. 81, 1938.
Spilomegastigmus Cameron, Spolia Zeyl., vol. 3, p. 73, 1905.
Bootani Dalla Torre, Wien. ent. Ztg., vol. 16, p. 86, 1897.
Odopoia Walker, Notes on Chalcidae, Part 2, p. 36, 1871.
Bootanelleus Girault, Mem. Queensl. Mus., vol. 4, p. 308, 1915.

PROVISIONAL GENERIC KEY

1. Mandibles bidentate; head and thorax smooth; scutellum without cross furrow; antennae long, scape attaining lateral ocelli; hypopygium long, plough shaped; clypeus roundly incised ..... *Spilomegastigmus*
   Mandibles tridentate or quadridentate; head and thorax rugulose, punctate or aciculate 2
2. Antenna 12-segmented, with two ring segments; thoracic sculpture scaly; axillae advanced ..... *Bootanelleus*
   Antenna 13-segmented, with one ring segment 3
3. Mandibles tridentate; head and thorax rugulose, rugulose-punctate or aciculate 4
   Mandibles quadridentate; head and thorax sparsely or finely punctate 5
4. Median ventral margin of clypeus incised ..... *Megastigmus*
   Median ventral margin of clypeus lobed or toothed; front wing with pronounced apical infuscations ..... *Epibootania*
5. Abdomen subsessile, elongate, subcompressed, as long as the thorax; scutellum with cross furrow ..... *Bootania*
   Abdomen distinctly petiolate, short, elliptical, not compressed, shorter than thorax; petiole as long as propodeum; scutellum without cross furrow ..... *Odopoia*

NOMENCLATURE IN MEGASTIGMUS

Swederus (1795) was the first to describe species belonging to *Megastigmus*. The two species he described, *viz. bipunctatus* and *aculeatus*, were placed in *Pteromalus* which was the name he then proposed for the chalcids. Three years later, evidently unaware that Swederus had proposed *Pteromalus*, Fabricius (1798) described two attractive metallic species, *dorsalis* and *stigmatizans*, and placed them in *Ichneumon*. During the subsequent two decades, the latter two species in particular were assigned to various genera, depending

on the authority. For instance, in 1804, Fabricius himself transferred *dorsalis* to *Diplolepis* and, for no apparent reason, changed the name of *stigmatizans* to "*stigma*" and referred it to the genus *Cleptes*. This new name employed for the latter species was adopted by Jurine (1807) for this megastigmine species included in his *Chalcis*. In two publications, Spinola, (1806, 1808), considered *dorsalis* under *Diplolepis*. Later (1811), in referring to *stigmatizans*, he used "*stigma*" in the genus *Decatoma*, and at that time placed *dorsalis* in *Callimome* (a name then proposed by Spinola). Lamarck (1817, 1835) put *dorsalis* in *Cynips*.

Dalman (1820), among the earlier workers, contributed much to bring order out of chaos. Unaware of the fact that Spinola (1811) had already suggested the name *Callimome*, *Torymus* was proposed for one of the genera erected in subdividing *Pteromalus* of Swederus. *Torymus* was then divided into three subgroups or subgenera: *Megastigmus*, *Torymus* proper, and "Anomali," each of which was briefly characterized in his *Synopsis Specierum Sveciae*. *Megastigmus* was proposed to include three species, *viz.*, *bipunctatus* (Swed.), "*collaris*" and "*chloronotus*." The last two names were *nomina nuda* in the modern sense, because they were without descriptions. Dalman did not recognize either *aculeatus* or *dorsalis* as belonging to *Megastigmus*, though he had before him specimens representing both species to which he unfortunately assigned the above new names. Thus, as Crosby (1913) has already indicated in his designation of the genotype, *Megastigmus* contained originally but a single described species, *bipunctatus*, which must be accepted as the genotype.

Boheman (1834) attempted to finish the work begun by Dalman, whose death occurred in 1828. His classification was in all respects precisely the same. In treating the species of *Megastigmus*, which he likewise considered a subgenus of *Torymus*, he described *collaris* and placed "*chloronotus*" in synonymy with *dorsalis*. Although Boheman was able to settle the identity of one of Dalman's three species, he too failed to recognize that *aculeatus* and *collaris* were one and the same species, the original synonymy of which should be credited to Thomson (1875).

For several years after Dalman's work appeared, certain species of *Megastigmus* were treated biologically or taxonomically under other generic names. Fonscolombe (1832) followed Lamarck in using *Cynips* but later (1840) employed *Megastigmus*. In the interim, Walker (1833) was the first to establish the generic status of Dalman's *Megastigmus*. Later, Nees ab Esenbeck (1834) and Förster (1841) used *Torymus*, but in a subsequent publication the latter (1859) recognized Dalman's genus. Worthy of note is Dufour's (1847) biological reference to *stigmatizans*, which he placed in Latreille's *Misocampus*, a synonym of *Callimome* Spinola.

Among those who have since made important taxonomic contributions, we may cite several. The first revision of *Megastigmus* was that by Mayr (1874): it forms a part of the work known under the abridged title, *Die europaischen Torymiden*. This was followed by Thomson's (1875) revision of the Swedish species as a part of the general treatment of *Pteromalus* of Swederus in *Hymenoptera Scandinaviae*. Considerable importance must be attached to the

contributions in *Catalogus Hymenopterorum* by Dalla Torre (1898), *Classification of the Chalcid Flies* by Ashmead (1904b), and "Chalcididae" in *Genera Insectorum* by Schmiedeknecht (1909). The first revision of the North American species was that by Crosby (1913). Seitner (1916) published a paper on the European species infesting conifers and briefly treated other species. Yano and Koyama (1918a, b) have contributed to the knowledge of the Japanese species, and Girault (1915 *et seq.*) has been concerned chiefly with Australian forms. The publications of Hoffmeyer (1929 *et seq.*) deal principally with European and North American species. The most recent contribution is that by Escherich (1938), who has added materially to the knowledge of the conifer infesting species of Europe in particular.

MEGASTIGMUS Dalman

Genotype: *Pteromalus bipunctatus* Swederus.
Designated by Crosby, 1913*

Torymus (*Megastigmus*) DALMAN, Kongl. Vet. Acad. Handl., "Synopsis," p. 178, 1820: BOHEMAN, Kongl. Vet. Acad. Handl., p. 331, (1833) 1834.

Megastigmus Dalman, WALKER, Ent. Magaz., vol. 1, p. 116, 1833: WESTWOOD, Introd. mod. classif. insects, vol. 2, "Synopsis," p. 67, 1840: BRULLE, *In* Lepeletier's "Hist. nat. des Insectes," vol. 4, p. 568, 1846: RATZEBURG, Ichneum, d. Forstinsect., vol. 2, p. 182, 1848: MAYR, Verh. k. -k. zool.-bot. Ges. Wien, vol. 24, p. 64, 1874: THOMSON, Hymen. Scand., vol. 4, p. 61, 1875: CRESSON, Trans. Amer. Ent. Soc., suppl. vol., p. 68, 1887: DALLA TORRE, Cat. Hymen., vol. 5, p. 285, 1898: ASHMEAD, Mem. Carnegie Mus., vol. 1, p. 245, 1904: SCHMIEDEKNECHT, Gen. Insect., fasc. 97, p. 118, 1909: CROSBY, Ann. Ent. Soc. Amer., vol. 6, p. 155, 1913: GIRAULT, Trans. & Proc. Roy. Soc. S. Aust., vol. 37, p. 80, 1913; Mem. Queensl. Mus., vol. 4, p. 297, 1915; GAHAN & FAGAN, U. S. Nat. Mus. Bul. 124, p. 84, 1923.

Trogocarpus RONDANI, Boll. Soc. ent. ital., vol. 9, p. 204, 1877: DALLA TORRE, Cat. Hymen., vol. 5, p. 315, 1898: GAHAN & FAGAN, U. S. Nat. Mus. Bul. 124, p. 150, 1923. (Genotype: *Trogocarpus ballestrerii* Rond., monobasic.)

Megalostigmus SCHULZ, Spolia Hymen., p. 147, 1906 (Emendation): GAHAN & FAGAN, U. S. Nat. Mus. Bul. 124, p. 84, 1923.

Xanthosomoides GIRAULT, Can. Ent., vol. 45, p. 220, 1913: GAHAN & FAGAN, U. S. Nat. Mus. Bul. 124, p. 153, 1923. (Genotype: *Xanthosomoides maculatipennis* Gir., orig. desig.).

Epimegastigmus GIRAULT, Mem. Queensl. Mus., vol. 4, pp. 297, 307, 1915: GAHAN & FAGAN, U. S. Nat. Mus. Bul. 124, p. 55, 1923. (Genotype: *Xanthosomoides fulvipes* Gir., orig. desig.). *New synonymy.*

DEFINITION OF THE GENUS

Megastigmus was originally defined by the following brief combination of characters: *"Stigma incrassatum magisque determinatum: collare majusculum: corporis color non metallicus."* Apparently Dalman interpreted the dorsal color pattern of his *"chloronotus"* as being non-metallic, yet it ap-

* *Diplolepis dorsalis* (Fabr.), designated by Westwood (1840, "Synopsis," p. 67), and *Ichneumon dorsalis* Fabr., designated by Ashmead (1904, p. 245), were not originally included.

proaches that condition. Some have referred to the color of these metallic forms as being smaragdine, but bluish and aeneous casts are often present on *dorsalis* and allied species. Color is no longer considered important in defining the genus.

Walker (1833) was first to advance an adequate set of characteristics as follows: "*Caput medium: palpi maxillares articulis 1, 2 et 3 subaequalibus: mentum ovatum, antice acuminatum, postice subquadratum: mandibulae arcuatae, tridentatae: antennae subclavatae, pilosae, articulo 1°. elongata, 2°. brevicyathiformi, 3°. brevissimo, 4°. et sequentibus ad 10um. latoribus longitudine decrescentibus, tribus ultimis approximatis: pedes subaequales: thorax convexus: proscutellum elongatum, antice angustatum aut fere subquadratum: mesoscutellum convexum: abdomen elongatum, convexum,* **Maris** *petiolatum,* **Feminae** *sessile: oviductus exsertus.*" Walker's reference to the maxillary palpi and tarsi have proved of little value; his description of the female abdomen is not entirely applicable; and subsequent authorities have in most instances avoided the statement that the male abdomen is petiolate. However, Mayr (1874), who hardly added anything to further clarify the generic concept, referred to this latter point in his key as, "der Hinterleib beim Männchen an der Basis stark verschmälert, fast stielförmig."

The somewhat shorter Latin description by Thomson (1875) mentioned several of the essential features of the genus as we regard it today. His description included the very important character of the enlarged stigma.

Ashmead (1904) characterized *Megastigmus* in key form as: "Head and thorax smooth or transversely wrinkled or aciculate; mandibles 3-dentate; head seen from in front a little wider than long, the ocelli placed in a slight curved line; scutellum with a cross furrow before apex." The last mentioned character is not constant throughout, for while it is present on most Nearctic species, there are some on which it is obliterated by coarse sculpture or it may be so weak as to be inconspicuous. With regard to sculpture, none of the species now known to the writer by either specimens or description fit the "smooth" condition of the head and thorax.

The following combination of characters is believed to be sufficient to separate *Megastigmus* from all other known genera of the subfamily Megastigminae:

Head subglobose, with distinct occipital carina; clypeus usually semicircular, with deep median incision on ventral margin; mandibles tridentate, basal tooth smallest; antennae thirteen segmented, with one ring segment, club at most weakly enlarged; antennal scrobe usually deep and distinctly defined below. Pronotum well developed, from above rectangular or nearly quadrate, usually with conspicuous median flange on anterior dorsal margin; mesonotum usually with deep parapsidal furrows; scutellum large, depressed to strongly convex, usually with distinct transverse line; front wing with large, petiolate stigma of varying shape, less frequently subsessile. Propodeum large, variously sculptured, often elevated medially; abdomen sessile to subsessile, weakly to strongly compressed; ovipositor sheath prominently exserted as in *Callimome,* often exceeding entire body length. Sculpture usually transverse, somewhat variable but most often head and thorax either aciculate, rugulose or rugose, sometimes in part rugulose-punctate. Male similar to female except abdomen usually constricted or narrowed basally, and either strongly compressed or depressed.

TAXONOMY OF THE NEARCTIC SPECIES OF MEGASTIGMUS

SOURCES OF MATERIAL

The taxonomic portion of this investigation is based chiefly on the extensive collection of the U. S. National Museum, permission for the loan of which was procured through the office of Mr. C. F. W. Muesebeck. All of the available material once assembled and studied by C. R. Crosby was kindly lent by Dr. J. Chester Bradley, of the Department of Entomology, Cornell University, Ithaca. Much of the Canadian material was procured from the Canadian National Collection, Canadian Department of Agriculture, Ottawa, through the kindness of Dr. O. Peck. The numerous specimens reared at St. Paul, or those collected in Minnesota, form a part of the collection of the University of Minnesota, University Farm, St. Paul.

Also, the following have lent material for study from the collections of their respective institutions: Mr. E. T. Cresson, Jr., Academy of Natural Sciences, Philadelphia; Mr. Herbert F. Schwarz, American Museum of Natural History, New York; Mr. Edward S. Ross, California Academy of Sciences, San Francisco; Mr. John C. Shread, Connecticut Agricultural Experiment Station, New Haven; Mr. Hugh B. Leech, Entomological Laboratory, Canadian Department of Agriculture, Vernon, British Columbia; Mr. K. A. Salman, Forest Insect Laboratory, Bureau of Entomology and Plant Quarantine, U. S. Department of Agriculture, Berkeley, California; Mr. F. P. Keen, Forest Insect Laboratory, Bureau of Entomology and Plant Quarantine, U. S. Department of Agriculture, Portland, Oregon; Dr. H. H. Ross, Illinois State Natural History Survey, Urbana; Dr. R. H. Beamer, University of Kansas, Lawrence; Mr. C. W. Sabrosky, Michigan State College, East Lansing; and Professor H. A. Scullen, Oregon State College, Corvallis. Material in the Carnegie Museum, Pittsburgh, was examined also.

In addition, the following persons have either lent or donated specimens for study: Dr. Osmond P. Breland, University of Texas, Austin; Mr. Ralph Hopping, Vernon, British Columbia, Canada; Professor Clay Lyle, Mississippi State College, State College; Mr. R. R. Dreisbach, Midland, Michigan; Dr. S. Marcovitch, University of Tennessee, Knoxville; Mr. S. C. Schell, North Carolina State College, Raleigh; Professor G. F. Spencer, University of British Columbia, Vancouver, British Columbia, Canada; and Professor P. H. Timberlake, Citrus Experiment Station, Riverside, California.

TERMINOLOGY AND METHODS

In order to properly discern most of the characters used in the descriptions and the keys, it is essential to have access to a stereoscopic microscope with a magnifying power of eighty-five or more times, a lined micrometer eyepiece, and a strong, sharply focused light. All descriptions were drawn up using such equipment.

With some exceptions, the external morphological terminology employed in this paper is that adopted by James (1926) for *Harmolita*. Figures 1 and 3 to 6 inclusive illustrate parts to which reference is commonly made. The

wing veins are named according to the conventional system (Fig. 2). In one instance, however, there is apparently no suitable term for that portion of the "stigmal vein" which leaves what is known as the stigma in *Megastigmus*. This is referred to several times in this paper, and for the sake of convenience, as well as for uniformity in terminology, the writer chose to call it the *stigmal sector*; its equivalent in the Comstock-Needham System appears to be the remnant of the radial sector (Rs).

Because of the paucity of good specific characters in *Megastigmus* it seemed desirable to make the descriptions inclusive of all structures or morphological differences that in any way might aid in identification, in spite of the fact that variations will be encountered frequently. It should be emphasized that the description, or redescription, of each sex of a species is based on a single specimen only, unless otherwise noted; a new species is described from the holotype and allotype. Frequently additional remarks are included in parentheses throughout the descriptions where it is desirable to designate what appears to be the more usual or commonly encountered condition.

Only a few items in the descriptions need further comment. Measurements of the length of the malar space and ocellar lines are illustrated in figures 5 and 6. Sometimes these distances are very variable, particularly between large and small specimens of the same species, consequently their use cannot always be relied upon. The length of the malar space is most often equal to ½ the height of the compound eye, therefore, when no mention of the malar space is made this relation may be assumed to be the condition. The length of the scape is measured from its basal constriction to its distal end; the remaining antennal segments are measured on the dorsal aspect. The segments of the funicle are designated by "FI," "FII," etc. (Plate 1, fig. 1).

The body sculpture of various species of *Megastigmus* is strikingly similar. Since a transverse rugulose or rugose condition is common to nearly all of the Nearctic species, and to most of the exotic species, it would seem as though a mention or description of it in each species diagnosis would be unnecessary. Yet, significant differences in sculpture do appear obvious, particularly when specimens representing different species are at hand for comparison, and such differences are of considerable value, provided they can be adequately expressed in words.

For the purpose of uniformity, as well as for the immediate value in determining species, it seemed highly desirable to redescribe the Nearctic species of other authors. In this connection, all types have been examined except those of the following: *Brevicaudis* Ratz., *pinus* Parf., *rafni* Hoffm., *spermotrophus* Wach., *specularis* Wall., *hoffmeyeri* Wall., *aculeatus* (Swed.), *albifrons* Walk. and *variegatus* Strand. *Specularis* was redescribed from paratypes, while others of the above were redescribed from material determined by the writer.

VARIATIONS AND THE SPECIES PROBLEM

The fact that certain species of the genus are exceedingly variable is well demonstrated in the material that has been assembled for the study. In general, the variations can be associated with differences in hosts. However, *M.*

nigrovariegatus from the same host may show almost as much variation in color as do specimens reared from a long series of different host species. Variation in color alone would not be a difficult problem were it not for the accompanying structural variations that occur in certain species. *Pinus* Parf. is one of the best examples of a species that appears to be exceedingly variable in both color and structure, and such differences apparently are governed to an important degree by the host species from which it is reared. The examined material of this species can be segregated roughly into about three or four groups, corresponding to different hosts, on the basis of certain composite characters which, however, do not appear to be constant enough for recognition of more than a single species. At any rate, the writer at present hesitates to recognize that these specimens represent more than a single species, or that they represent subspecific or varietal categories, in view of the need for further studies particularly those of a biological nature. *Rafni* Hoffm. is similar to *pinus* but varies to a less extent according to material examined. *Lasiocarpae* Cy. is another species which, while appearing to be fairly constant in color, does show marked structural modifications depending on the host species from which it is reared.

Other species are comparatively constant in color and structure. *Physocarpi* Cy. and its allied species are among those showing the narrowest range in variation. Consequently, the Nearctic megastigmine fauna contains species which are rather constant and others which are extremely variable.

Naturally, when host-related, composite variations occur within what is really one species, it is often most difficult to define even species, to say nothing of subspecific categories. We commonly regard the term "subspecies" as having reference to that division or portion of a species population that is confined in its geographical distribution because of various topographic, climatic or physiologic barriers that exist between the populations of that particular species. Subspecies therefore may occur as the result of some "host barrier"; the phenomenon in this case may become apparent by some change in external appearance expressed as the end result of acquiring a definite degree of specificity for a given host under natural conditions. It is in this sense that the term "subspecies" perhaps should have been employed in this paper for certain forms that are called varieties, for example, those of *aculeatus*, *spermotrophus* and *tsugae*.

By way of summarizing the preceding cursory remarks, it may be stated that (1) some of the variation within species of *Megastigmus* can be directly correlated with selection of different hosts; (2) the most variable species are those having the widest host preferences; (3) what appears to be host effect results largely in modification of coloration in some species, while in others structural modifications are discernible. Since the host appears to exert a marked effect on the species, any attempt at ascertaining specific limits in certain instances, and particularly the possible subspecific limits, will of necessity be clouded with some degree of uncertainty until we have learned how and to what extent this host factor is operating.

KEY TO THE NEARCTIC SPECIES OF MEGASTIGMUS

1. Females 2
   Males 27

2. Species with the ovipositor sheath shorter than the abdomen, or at most only slightly longer by actual measurement 3
   Species with the ovipositor sheath distinctly longer than the abdomen (except *tsugae* var. *heterophyllae*, which goes here, may have the sheath only slightly exceeding the abdomen, but the head and pronotum are lemon yellow for the most part) 9

3. Stigma narrow-elongate (Figs 7 & 9), usually pointed; pronotum distinctly transverse, weakly arched above and without sharp transverse rugae; mesopraescutum with very fine, reticulate sculpture; small species (1.2 to 2.2 mm.) 4
   Stigma more or less oval or circular; pronotum wider than long but more strongly arched and usually with at least one distinct transverse ruga 5

4. Ovipositor sheath very short, only slightly more than one-half as long as the abdomen; mesonotum, except the mesoscutum, black ..... *gahani*, n. sp., p. 275
   Ovipositor sheath as long as, or slightly longer than the abdomen; mesonotum brownish yellow (or orange) ..... *physocarpi* Cy., p. 272

5. Vestiture on the thoracic dorsum rather long and pale; scutellar area behind transverse line usually entirely smooth and polished 6
   Vestiture on the thoracic dorsum dark; scutellar area behind transverse line sculptured 7

6. Stigmal vein noticeably thickened at junction with the stigma (Fig. 11, left) which is directed more or less toward the outer wing margin; legs, front coxa, triangular spot on the side of the pronotum, front and gena adjacent to the posterior eye margin lemon yellow ..... *amelanchieris* Cush., p. 282
   Stigma not noticeably thickened as above and directed more toward the posterior wing margin; legs tawny yellow; head, pronotum and all coxae entirely black ..... *melanus*, n. sp., p. 302

7. First segment of the hind tarsus fully twice as long as the second; stigmal vein short (Fig. 15); pronotum with several sharp, transverse rugae; color almost entirely brownish yellow ..... *floridanus*, n. sp., p. 342
   First segment of the hind tarsus less than twice as long as the second segment; color darker than above to nearly entirely black 8

8. Ovipositor sheath shorter than the abdomen and usually strongly arched upward; stigma oval to nearly circular (Fig. 8); vestiture on the thoracic dorsum fine and moderately dark, that on front laterad of the antennal scrobe pale ..... *brevicaudis*, Ratz., p. 278
   Ovipositor sheath as long as, or slightly longer than the abdomen and evenly arched upward to nearly straight; stigma elongate-oval (Fig. 10, left); vestiture on thoracic dorsum stronger and darker, a few dark hairs on the dorsal area of the front laterad of the antennal scrobe; color variable from entirely brownish yellow or orange to almost entirely brownish black without sharply defined markings ..... *americanus*, n. sp., p. 285

9. Stigma surrounded by a distinct infuscated area, rarely only weakly indicated (Fig. 14, left); ovipositor sheath shorter than the body; color very variable but usually brownish yellow ..... *nigrovariegatus* Ashm., p. 294
   Stigma not surrounded by an infuscated area; if so, then ovipositor sheath distinctly longer than the body 10

10. Infuscated spot behind the distal portion of the submarginal vein, rarely absent;

scape long, distinctly curved; sculpture coarse, rugae sharp ..... *albifrons* Walk., p. 336

Wing without infuscated spot behind the submarginal vein 11

11. Ovipositor sheath shorter than the thorax and the abdomen combined 12

Ovipositor sheath as long as, or distinctly longer than the thorax and the abdomen combined 15

12. Pedicel at most only very slightly longer than FI; stigma elongate-oval (Fig. 21, left); stigmal vein not conspicuously long; color entirely brownish yellow, (or orange) ..... *hoffmeyeri* Wall., p. 311

Pedicel distinctly longer than FI; color black or black and yellow 13

13. Greatest width of pedicel from above not noticeably exceeding the width of FI (pedicel elongate-oval); propodeum usually with a distinct carina; side of pronotum dark brown ..... *laricis* Marc., p. 299

Greatest width of pedicel from above perceptibly a little wider than FI (pedicel more nearly oval); propodeum usually without a strong median carina; at least side of the pronotum with a yellow spot 14

14. Pronotum with a large yellow spot at the side; stigma rectangular (Fig. 20, left); stigmal vein comparatively long; scutellum behind the transverse line, and the propodeum longitudinally sculptured ..... *tsugae* Cy., p. 308

Pronotum mostly yellow; remainder of the thorax and the abdomen with much yellow; stigma oval to rectangular (Fig. 19, left) ..... *tsugae* var. *heterophyllae*, n. var., p. 309

15. Pedicel from above elongate, perceptibly longer than FI 16

Pedicel from above at most only slightly longer than FI 19

16. Stigma surrounded by a rather distinct infuscated area (Fig. 23); sculpture coarse, the thorax with very sharp, transverse rugae; ovipositor sheath distinctly longer than the body; vestiture pale; color tawny brownish yellow with a dorsal longitudinal stripe ..... *formosus*, n. sp., p. 339

Stigma not surrounded by a distinct infuscated area; ovipositor sheath not as long as above; vestiture dark 17

17. Pronotum with a large yellow spot at the side and two on the dorsum; neither front below the antennal bases, nor the legs distinctly infuscated; abdomen with yellow markings at the side ..... *piceae* var. *montana*, n. var., p. 305

Pronotum entirely black 18

18. Front below the antennal bases usually infuscated and bearing some dark hairs; anterior surface of the hind femur with distinct infuscation; propodeum with short, weak carinae anteriorly; stigmal sector long and pointed; color of thorax and abdomen black ..... *piceae* Rohw., p. 303

Front not infuscated below the antennal bases; propodeum with a strong, transverse elevation on the anterior margin; abdomen black with yellow markings ..... *caperatus*, n. sp., p. 306

19. Length of scape about equal to that of the pedicel, the ring segment and FI combined; color predominantly black or black and yellow 20

Length of scape distinctly longer than that of the pedicel, the ring segment and FI combined; color predominantly brownish yellow 23

20. Most of the vestiture on the thoracic dorsum pale; color black and yellow; oblong reddish orange (or yellow) spot covering the posterior half of the mesopraescutum, inner angles of the mesoscutum and axilla ..... *pinus*, Parf., p. 318

Most of the vestiture on the thoracic dorsum black 21

21. Pronotum (except usually two insolated dorsal spots) and most of the remainder of the thoracic dorsum yellow; abdomen banded with yellow; anterior margin of the scutellum one-half or less the posterior margin of the mesopraescutum ..... *milleri*, n. sp., p. 323

Pronotum (except sometimes two brownish or yellow spots on the posterior margin) and the mesonotum black 22

22. Inner surface of the scape bearing conspicuous, strong dark hairs; face infuscated, also bearing dark hairs; hind femur with a wide, median dark band; pronotum with a dorsal yellow spot at the side ..... *lasiocarpae* Cy., p. 326

Inner surface of the scape with short, light hairs; face and legs without distinct infuscations; pronotum with two spots above on the posterior margin, and the side tawny yellow ..... *specularis* Wall., p. 328

23. Stigmal vein much shorter than the stigmal width (Figs. 12 & 13, left); vertex of head depressed; general color variable but usually brownish yellow with the outer half of the axilla dark brown 24

Stigmal vein as long as, or longer than the stigmal width (Figs. 27 & 31, left); vertex of head not depressed 25

24. Ovipositor sheath longer than the body; general color brownish yellow with the outer half of the axilla dark brown ..... *aculeatus* (Swed.), p. 289

Ovipositor sheath more nearly equal to the thorax and the abdomen combined; color as above, but usually with a conspicuous infuscation on the temple and abdomen above; parapsidal furrow usually dark ..... *aculeatus* var. *nigroflavus* Hoffm., p. 293

25. Proximal funicular segments alike, nearly equal and each twice as long as wide; dorsal measurements of the first hind tarsal segment nearly twice that of the second; head somewhat elevated on the vertex; ovipositor sheath longer than the body and most often distinctly so; color variable from yellow (greenish or brownish) with dark brown or black markings, to almost entirely brownish yellow ..... *rafni* Hoffm., p. 331

Only FI fully twice as long as wide, it being slightly longer (and usually narrower) than the succeeding segments; dorsal measurements of the first hind tarsal segment approximately 1 1/3 as long as that of the second; ovipositor sheath at most only about as long as the body 26

26. Body color superficially uniform brownish yellow (light testaceous) or yellowish brown, the posterior dorsal margin of the pronotum yellowish but usually not contrasting sharply with the mesonotum; size medium (aproximately 3-4.5 mm.); sculpture and vestiture not especially strong ..... *spermotrophus* Wachtl, p. 313

Body color mostly deep rufescent amber to darker yellowish brown, the posterior dorsal margin of the pronotum yellow and contrasting sharply with the darker mesonotum, especially the dark brown or black anterior mesopraescutal margin; size larger (approximately 5 or more mm.); sculpture sharp and vestiture strong ..... *spermotrophus* var. *nigrodorsatus*, n. var., p. 316

27. Scape much expanded distally; infuscated spot behind the distal portion of the submarginal vein ..... *albifrons* Walk., p. 336

Scape not expanded distally; wing behind the distal portion of the submarginal vein entirely hyaline 28

28. Abdomen normally depressed, ovate in outline from above 29
Abdomen normally compressed 30

29. Mesonotum except the mesoscutum, black ..... *gahani*, n. sp., p. 275
Mesonotum brownish yellow ..... *physocarpi* Cy., p. 272

30. Stigma usually large, circular and surrounded by a distinct, wide infuscated area (Fig. 14, right) which is rarely absent; color variable from brownish yellow to black ..... *nigrovariegatus* Ashm., p. 294

Stigma not as above 31

31. Pedicel from above elongate-oval, about as long as, or longer than the ring segment and FI combined 32

Pedicel from above more oval, shorter than the ring segment and FI combined 37

32. Vestiture on the thoracic dorsum and face entirely pale; color black and lemon yellow ..... *amelanchieris* Cush., p. 282

Vestiture on the thoracic dorsum black 33

33. Dorsum of the pronotum black (except sometimes two very narrow transverse or indefinite yellowish spots on the posterior margin, in which case the abdomen is entirely tawny or brownish yellow beneath) 34

Dorsum of the pronotum with two large, triangular bright yellow spots on the posterior margin, or mostly yellow 36

34. Hind femur infuscated; dorsal area of the front laterad of the antennal scrobe with strong, black hairs; abdomen entirely black or nearly so ..... *piceae* Rohw., p. 303

Hind femur not infuscated; dorsal area of the front laterad of the antennal scrobe with finer, dark hairs; abdomen with much tawny or brownish yellow, especially beneath 35

35. Propodeal sculpture weak except for a fine median carina; stigma circular (Fig. 18, right); FI distinctly shorter than the pedicel by actual measurement; side of the pronotum largely dark to yellowish brown ..... *laricis* Marc., p. 299

Propodeal sculpture irregular and coarser; stigma oval (Fig. 10, right); FI subequal to the pedicel; side of the pronotum mostly tawny yellow ..... *americanus* n. sp., p. 285

36. Dorsum of the pronotum mostly yellow; general color tawny yellow and brownish black; stigmal vein rather long (Fig. 19, right) ..... *tsugae* var. *heterophyllae* n. var., p. 309

Dorsum of the pronotum black except two large, triangular yellow spots on the posterior margin; side of the pronotum nearly entirely yellow ..... *piceae* var. *montana*, n. var., p. 305

37. Vestiture on the thoracic dorsum mostly pale ..... *pinus* Parf., p. 318

Vestiture on the thoracic dorsum mostly dark 38

38. Mesopraescutum entirely black and usually the remaining thoracic dorsum as well 39

Mesopraescutum not entirely black, if nearly so, then the remainder of the thoracic dorsum with much lemon yellow 41

39. Dorsum of the pronotum entirely black, or at most with two small yellow spots on the posterior margin; cheeks with numerous black hairs; hind femur infuscated ..... *lasiocarpae* Cy., p. 326

Dorsum of the pronotum usually with two large yellow spots on the posterior margin; otherwise not as above 40

40. Median piece of the metanotum yellow; anterior margin of the scutellum about one-half as wide as the posterior margin of the mesopraescutum; inner angle of the axilla and the antero-lateral margin of the scutellum frequently with brown or brownish yellow; mesopleurum and hind coxa mostly black ..... *milleri*, n. sp., p. 323

Median piece of the metanotum black; anterior margin of the scutellum wider than above; mesopleurum usually tawny yellow ..... *specularis* Wall., p. 328

41. Vertex of the head (especially the ocellar region) depressed or flattened; stigmal vein short 42
Vertex of the head normally convex 43

42. Seventh abdominal tergum largely dark brown; mesal margin of the stigma more evenly arcuate (Fig. 12, right); stigma without trace of a surrounding infuscation ..... *aculeatus* (Swed.), p. 289
Dark brown on the seventh abdominal tergum usually reduced to more or less distinct latero-dorsal spots; mesal margin of the stigma frequently weakly angulate (Fig. 13, right); stigma often surrounded by a narrow, inconspicuous infuscation ..... *aculeatus* var. *nigroflavus* Hoffm., p. 293

43. Hind tarsus distinctly greater than two-thirds of the hind tibiae; proximal tarsal segments rather long, the dorsal measurement of the first about 1 2/3 that of the second; color mostly brownish yellow with dark brown or black markings; outer half of the axilla black ..... *rafni* Hoffm., p. 331
Hind tarsus nearer to two-thirds as long as the hind tibia; proximal segments of the hind tarsus comparatively shorter than above 44

44. Dorsum of the abdomen and thorax with much black ..... *spermotrophus* var. *nigrodorsatus*, n. var. p. 316
Dorsum of the abdomen (except sometimes the basal terga) and the thorax with little or no black 45

45. Thorax and abdomen mostly lemon yellow; propodeum usually with a distinct median carina; proximal 2/3 of the submarginal vein with 12 to 16 conspicuous bristles; size medium (2.7 to 3.7 mm.) ..... *spermotrophus* Wachtl, p. 313
Thorax and abdomen mostly brownish yellow; propodeum frequently with an interrupted, weak median carina; proximal 2/3 of the submarginal vein with about 10 conspicuous bristles; size small (1.8 to 2.4 mm.) ..... *hoffmeyeri* Wall., p. 311

DESCRIPTION OF SPECIES

MEGASTIGMUS PHYSOCARPI Crosby

Fig. 7

Megastigmus physocarpi Crosby, Ann. Ent. Soc. Amer., vol. 6, p. 158, 1913 (in part): Gahan, Proc. Ent. Soc. Wash., vol. 24, pp. 40, 52, 1922 (in part).

Female—Length, 1.8 mm.; abdomen, 0.8 mm. Ovipositor sheath, 0.9 mm. Head from above oval, about 1½ times wider than long; vertex mostly evenly convex, with very fine, somewhat indefinite transverse rugulae posteriorly, and arcuate rugulae anteriorly continuing onto front; face finely rugulose except irregular transverse sculpture below antennal bases; gena almost smooth; length of malar space slightly more than ½ height of compound eye which is nearly circular; occipital carina fine, evenly rounded above, not attaining top of vertex; ocelloccipital line equal to or slightly less than ocellocular line, or a little more than ½ posterior ocellar line (5/8); antennal scrobe only moderately deep, not defined laterally by strong carina; scape almost equal to combined lengths of pedicel, ring segment, FI and FII; pedicel elongate-oval, distinctly wider and almost twice as long as FI; funicular segments about equal but gradually increase in width. Pronotum from above rectangular in outline, wider than long, its dorsum depressed or at most weakly arched from side to side, with very fine, weak transverse rugulae or aciculations, and narrow flangs on anterior dorsal margin weakly emarginate; mesopraescutum finely transversely reticulate-rugulose; sculpture on mesoscutum weak, transverse reticu-

late-rugulose; axilla with weak oblique rugulae; scutellum somewhat acutely rounded anteriorly, reticulate with smooth area anterior to transverse line, that behind transverse line mostly rugulose-punctate; vestiture of thorax, especially of pronotum, sparse and relatively fine; scutellar hairs (usually 2 or 3 on each side) widely spaced and restricted to row very near lateral margin. Propodeum with delicate (irregular) median carina, and few short longitudinal carinae extending from anterior margin posteriorly to delicate transverse ridge, behind which sculpture is mostly reticulate-punctate enclosed by lateral arcuate carinae; propodeal spiracle small, oval, groove below shallow; abdomen not strongly compressed, polished, and with sparse vestiture; ovipositor sheath nearly straight or only weakly curved upward.

Color brownish or orange yellow to amber. Head entirely light brownish yellow except face and lower genal area more yellow, and ocelli in part surrounded by dark brown patches (each patch often extending in form of brown projection connecting ocelli or directed toward antennal scrobe); scape distally and pedicel basally brown above, remainder of these segments tawny yellow, and flagellum brown except lighter beneath. Pronotum mostly concolorous with head (usually somewhat darker on anterior median dorsal area and lighter along posterior margin and laterally); mesothorax and metathorax darker orange yellow (often posterior dorsal area of mesoscutum more yellowish); coxae yellow except hind coxa orange yellow basally; remainder of legs yellow except posterior surface of front femur and anterior surface of hind femur somewhat darker. Propodeum concolorous with mesothorax except carinae darker (often anterior area very dark orange to brown or black); abdomen dark or reddish amber above, lighter at side; base of tergum III (apparent first) and extreme caudal segments yellowish; ovipositor sheath dark brown to black with lighter brownish spot near distal end.

Vestiture pale. Proximal ⅔ of submarginal vein with about 6 or 7 strong bristles; stigma narrow and elongate, pointed on lower margin, with faint cloud at side (Fig. 7, left); stigmal vein and stigmal sector about equal.

Male—Length, 1.7 mm.; abdomen, 0.6 mm. Head much like that of female in shape and sculpture; length of malar space about ½ height of compound eye; ocelloccipital line about equal to ocellocular line or ½ posterior ocellar line; antennal scrobe relatively deep but not defined by sharp carinae; scape about as long as combined length of pedicel, ring segment, FI and ½ FII; pedicel oval, little wider but nearly twice as long as FI which is almost as wide as long and subequal to FII; remaining funicular segments nearly equal in length, each but slightly longer than wide. Sculpture and shape of thorax much as in female. Sculpture of propodeum like that of female (except sometimes median carina weaker, more irregular and lateral carina stronger, sharply delimiting groove below spiracle); abdomen depressed, polished except very minute punctures dorsally on terga beyond IV.

Color similar to that of female but in part lighter. Head yellow except somewhat more orange on vertex; ocelli surrounded in part by brown to black patches which converge toward antennal scrobe as in female (such markings

are very variable and may be entirely absent); color of antenna lighter than that of female, approaching tawny yellow. Pronotum, except anterior median dorsal area, yellow (though often mostly orange); otherwise thorax colored as in female; legs yellow. Abdominal tergum II (apparent first) mostly amber (brown medially above on some); terga IV to VII inclusive each with dark brown to black on dorsum, brownish yellow at sides, with complete transverse posterior amber border (dark above usually more extensive posteriorly, and yellow at side successively reduced); terga VIII and IX brownish or orange yellow.

Vestiture like that of female. Proximal ⅔ of submarginal vein with 6 strong bristles; stigma oval, surrounded by circular cloud almost as intense in color as stigma proper (Fig. 7, right); stigmal sector about as long as stigmal vein.

Redescribed.—Lectotype, female, Allentown [Allenton?], Mo., Oct., 1893, ex *Physocarpus opulifolius*, G. W. Letterman; lectoallotype, with same data (antennae beyond ring segment missing). Types in the collection of the U. S. National Museum, under number 27517.

The following paratypes have been examined: 4 females, 5 males, with the same data as the type; 1 male, Kirkwood, Mo., July 1, 1895 (from seeds, *Physocarpus*, 6502, Iss). Paratypes are in the collections of the U. S. National Museum and Cornell University.

Type Locality.—Allentown, Missouri.

Host.—Seeds of *Physocarpus opulifolius* (L.) Maxim. and the variety *intermedius* (Rydb.) Rob. The specific host of a single female examined from Moscow, Idaho, is unknown but possibly it is either *P. malvaceus* Kuntze or *P. monogynus* Coult.

Variations—Female. The ocellar lines are somewhat variable in length. Some specimens possess a shallow, smooth but noticeable depression between the anterior ocellus and the dorsal area of the antennal scrobe. The propodeal carination is subject to the same degree of variation as in other species; sometimes the median carina is distinct only on the posterior half or it may be interrupted medially, and the transverse ridge may not be as prominent on others. Frequently the clouded area about the stigma is more extensive and the stigmal shape may be more elongate-oval than described; or the cloud may be almost completely absent. Only over limited areas are there marked variations in color. The head of lighter specimens may be yellow, and of darker individuals, orange yellow. More rarely, the dorsum of the head, median dorsal area of the pronotum and the dorsum of the mesothorax for the most part may have a brownish cast. The variability of the pattern about the ocelli has already been pointed out; sometimes the ocellar area is merely deeply infuscated with dark brown or black. The legs may appear brownish yellow, especially the femora. The amount of dark on the propodeum and the abdomen is subject to some variation in intensity. There is not a single female in the type series with a very dark anterior area on the propodeum, although it appears on other specimens examined. Dark individuals may have the dorsal areas of the median abdominal terga dark brown. Females vary in size as follows: Length, 1.2 mm. to 1.9 mm.; abdomen, 0.6 mm. to 0.9 mm. Ovipositor sheath, 0.6 mm. to 0.8 mm.

Male. Similar structural variations are exhibited by males as those de-

scribed for the female. Frequently the transverse lateral and median carinae on the propodeum are so weak as to be almost imperceptible. Normally, the stigma is broadly oval; due to the surrounding cloudiness it may appear circular, particularly when the infuscation is very intense. As a rule, the head, prothorax and legs of the male are lighter. The most obvious variation is concerned with extent of dark color about the ocelli, on the propodeum and on the abdomen. The median abdominal terga of some specimens have the dark brown extending to the side, or the dark dorsal pattern may be considerably restricted or absent on lighter specimens. The anterior dorsal area of the propodeum may show varying shades of orange to brown or black. Males vary in size as follows: Length, 1.3 mm. to 1.8 mm.; abdomen, 0.5 mm. to 0.6 mm.

Distribution.—Indiana, Idaho; Michigan, Minnesota, Missouri, Canada (Ontario, Quebec).

Comments—This species and the following are very closely related though structurally distinct. *Physocarpi* females can be separated at once from those of *gahani*, n. sp., by the possession of an ovipositor sheath as long or slightly longer than the abdomen, the absence of black on the mesopraescutum and the generally lighter body color, and the stouter stigma. Males of this species also lack black on the mesopraescutum.

Crosby (1913, p. 158) had before him two species. He described the lighter of them as *physocarpi*, and considered the following species as a mere variety.

Records indicate that this species may prove to be more common in the East, while the following species may be mostly restricted to the areas from the Mississippi River westward.

Megastigmus gahani n. sp.

Fig. 9

Megastigmus physocarpi Crosby, Ann. Ent. Soc. Amer., vol. 6, p. 158, 1913 (in part): Gahan, Proc. Ent. Soc. Wash., vol. 24, pp. 40, 52, 1922 (in part).

Female—Length, 1.7 mm.; abdomen, 0.6 mm. Ovipositor sheath, 0.3 mm. Head oval from above, about 1 1/3 wider than long; face finely rugulose; gena mostly smooth; length of malar space almost ⅔ height of compound eye which is somewhat circular, not bulging; occipital carina fine and sharp, evenly arcuate above, not attaining top of vertex; ocelloccipital line equal to ocellocular line or slightly greater than ½ posterior ocellar line; antennal scrobe shallow; scape about equal to pedicel, ring segment, FI and FII; FII slightly shorter than FI which is about twice as long as wide; remaining funicular segments about equal and successively wider. Thoracic sculpture very similar to that of *physocarpi*; pronotum from above rectangular, wider than long, depressed as in *physocarpi*, crossed by fine irregular rugulae that are most distinct anteriorly, and its anterior margin with very narrow and imperceptibly emarginated flange; mesopraescutum with more arcuate, fine reticulate rugulae continuing onto mesoscutum; axilla finely and obliquely

rugulose, more reticulate on inner angle; scutellum truncately rounded at anterior margin, mostly reticulate to transverse line, behind more longitudinally sculptured or more coarsely reticulate-punctate. Propodeum with very irregular, delicate median carina (which may be weaker or branched posteriorly and have irregular transverse carinae arise from it), otherwise mostly punctate; propodeal spiracle small, oval, groove below practically absent; abdomen not strongly compressed, smooth and polished (usually contracted or noticeably telescoped); ovipositor straight, inclined upward; vestiture fine, sparse over entire body, especially on pronotum; scutellar hairs (usually 3 to 4 on each side) restricted to row near lateral margin.

Color tawny or brownish yellow, brown and black. Head entirely tawny or brownish yellow except narrow area between ocelli and occipital carina, occiput and postgena mostly, brown; ocelli narrowly surrounded with darker brown to black; scape and pedicel beneath and latter distally above, tawny yellow, remainder of these segments and flagellum brown. Pronotum tawny or brownish yellow except wedge-shaped dorso-median black spot which is widest near anterior margin and constricted at or near posterior margin; mesopraescutum, axilla, scutellum, and metanotum except its yellowish median piece, entirely black; mesoscutum tawny yellow suffused with pale brown on anterior dorsal surface; pleura and sterna mostly brownish yellow, except tawny spot under front wing base; legs tawny yellow except middle and hind coxae slightly darker, and tips of tarsi black. Propodeum black shading to yellowish brown on postero-lateral areas; abdominal tergum III (apparent first) dark brown above, lighter (amber) at base and side; terga IV to VII inclusive dark brown above, especially on IV and V, sides and sterna amber; remaining terga brownish yellow except dark brown to black surrounding cercus; ovipositor sheath dark brown to black.

Vestiture pale. Venation light brown; proximal ⅔ of submarginal vein with about 6 strong bristles; stigma relatively narrow, somewhat triangular and without distinct surrounding cloud (sometimes narrowly clouded at sides, especially mesially. Fig. 9, left).

Male—Length, 1.8 mm.; abdomen, 0.8 mm. Shape and sculpture of head very similar to that of female; length of malar space about 3/5 height of compound eye; antennal scrobe very shallow; scape slightly more expanded, nearly equal to pedicel, ring segment, FI and FII; pedicel wider than FI and just subequal to combined lengths of FI and FII; funicular segments about equal and each successively wider; ocelloccipital line slightly less than ocellocular line or slightly greater than ½ posterior ocellar line. Thoracic conformation (except slightly narrower) and sculpture like that of female. Propodeum with median carina more distinct; abdomen depressed, ovate, smooth and polished except very minute, almost imperceptible punctures distally above on terga V to VII; vestiture throughout like that of female in length and abundance.

Color lemon yellow and black. Head lemon yellow except brown patch enclosing ocelli and narrowly extending to occipital carina, which is brown dorso-medially (variable, sometimes brown patch being more broadly connected

with occipital carina, and dorsal area of occiput brown); scape distally and pedicel basally brown above; remainder of antenna, especially flagellum, light golden yellow, scape and pedicel slightly more tawny. Thoracic pattern and color of legs like those of female except tawny or brownish yellow replaced by lemon yellow. Propodeum black with approximate posterior 1/3 brownish yellow; abdominal tergum III (apparent first) amber (median dorsal area often with irregular brown patch); terga IV to VI inclusive each dark brown with posterior amber band, dark brown more constricted (usually) near posterior margin on VI, so that brownish yellow at side extends more toward median dorsal line; tergum VII like VI but with less extensive dark brown (or with lighter brown above); terga VIII and IX and sterna brownish yellow.

Vestiture pale. Stigma apparently circular but actually elongate-oval within dark circular clouded area (Fig. 9, right); proximal 2/3 of submarginal vein with 6 strong bristles.

Types.—Holotype, female, Houston County, Minn., May 26, 1940, H. E. Milliron (Ex seed, *Physocarpus opulifolius,* St. Paul, Minn., June 2, 1940). Allotype, with same data as the holotype except emerged May 30, 1940. Types are in the collection of the University of Minnesota. Paratypes: *Minnesota*—81 females, 173 males, Houston County, May 26, 1940, H. E. Milliron (Ex seeds, *P. opulifolius,* St. Paul, Minn., May 30-June 4, 1940); 9 females, 10 males, May 27, H. E. Milliron (Ex seeds, *P. opulifolius,* St. Paul, Minn., June 1, 1940): 3 females, 4 males, Frontenac, May 25, 1940, H. E. Milliron (Ex seeds, *P. opulifolius,* St. Paul, Minn., May 30-June 3, 1940): 5 females, John Latch State Park, May 25, 1940, H. E. Milliron (Ex seeds, *P. opulifolius,* St. Paul, Minn., June 1-5, 1940): 1 female, 3 males, Preston, May 28, 1940, H. E. Milliron (Ex seeds, *P. opulifolius,* St. Paul, Minn., June 1-3, 1940): 7 females, 3 males, University Farm, St. Paul, June 2, 1940, H. E. Milliron (Ex seeds, *P. opulifolius,* June 4-7, 1940). *Missouri*—17 females, 7 males, Allentown [Allenton ?], Oct. 1893, G. W. Letterman (In *P. opulifolius* seed). Paratypes are in the collections of the University of Minnesota, the U. S. National Museum and Cornell University.

Type Locality.—Houston County, Minnesota.

Host.—Seeds of *Physocarpus opulifolius* var. *intermedius* (Rydb.) Robinson. Minnesota specimens bearing only the specific name of the host were reared from the variety as given above, except those labeled "University Farm" are from the seeds of an unidentified, cultivated form appearing to be *luteus.* Specimens from Missouri were, in all probability, reared from the variety *intermedius.* The specific host of a single male from Colorado is unknown.

Variations—Female. Except for the carinae on the propodeum, and the shape of the stigma, females of this species do not exhibit marked variations in structure. Usually the propodeum is finely reticulate or coarsely punctate with a distinct median carina, the transverse and lateral carinae often being irregular in form and very variable in distinctness. Sometimes a shallow depression is evident just behind the anterior margin of the dorsum of the pronotum. The cloudiness about the stigma is evident in some and absent in others; shape of the stigma varies somewhat. The color about the ocelli varies in intensity and extent, and the occiput may be entirely brown; on darker individuals the genal area may be slightly infuscated. Most of the color variation occurs on the pronotum and abdomen; the dorsal black marking of the former part may vary in extent, and the fourth to the sixth abdominal terga may be very dark, depending on the intensity of the general

body color. The color of the median piece of the metanotum may be yellowish to black. Lighter colored areas in part may show a general cast of suffused brown on darker specimens; these areas on lighter females are tawny yellow to light amber. In general, however, the pattern throughout is relatively constant. Females vary in size as follows: Length, 1.2 mm. to 1.9 mm.; abdomen, 0.5 mm. to 0.7 mm. Ovipositor sheath, 0.2 mm. to 0.4 mm.

Male. In addition to the structural variations noted for the female, the following may be noted for the male. The base of the abdomen often appears noticeably constricted, the third tergum assuming an abnormal cylindrical shape in drying. Propodeal carination is finely reticulate or rather coarsely punctate, and the median carina is not constant in form. Regarding color, the brown vertex is often reduced and may not extend to the occipital carina. The longitudinal black marking on the dorsum of the pronotum is rarely completely constricted or attenuated behind, leaving only an anterior, triangular brown or black patch. The stripe may even attain similar proportions and shape as in the female. Yellowish color may appear on the extreme anterior side of the mesopraescutum along the parapsidal furrow and on the posterior area of the scutellum. The median piece of the metanotum is often yellow or yellowish, especially on lighter specimens. Abdominal terga IV to VII inclusive sometimes appear almost entirely dark brown to black dorsally, the third then being darker amber. Variation in size of males examined is as follows: Length, 1.3 mm. to 2.2 mm.; abdomen, 0.5 mm. to 0.8 mm.

Distribution.—Colorado, Minnesota, Missouri.

Comments—Crosby (1913, p. 158) based his description of *physocarpi* on the lighter of two distinct species reared from *Physocarpus opulifolius*, the specimens representing the darker species being considered as variants. The morphological study, as well as biological investigations (*Cf.* Part II) of numerous specimens reared from the seeds of this host has disclosed that two distinct species are involved.

This species is one of the most attractive and constant species of the genus. It is very closely related to *physocarpi* from which it can be distinguished easily by the possession of an ovipositor sheath only about ½ or less the length of the abdomen, and by the rather broad, longitudinal black stripe on the thoracic dorsum. The color character, being applicable to both sexes, will also serve to separate the males of the two species.

Additional records will be necessary before a precise statement on distribution can be made. However, it now appears that this species may be the more common western form of the two infesting the seeds of *Physocarpus*, and it is probable that it is chiefly confined to areas from the Mississippi River westward.

MEGASTIGMUS BREVICAUDIS Ratzeburg

Fig. 8

Megastigmus brevicaudis Ratzeburg, Ichneum. d. Forstinsect., vol. 3, p. 225, 1852 (♀ only): Riley, Proc. Ent. Soc. Wash., vol. 2, p. 362, 1893: Dalla Torre, Cat. Hymen., vol. 5, p. 286, 1898: Rodzianko, Bul. Soc. Imp. Nat. Moscou, vol. 21, pp. 601-602,

608-611, 1908: Crosby, Cornell Agr. Exp. Sta. Bul. 265, pp. 375-377, 1909 (♀ in part): Schmiedeknecht, Gen. Insect., fasc. 97, p. 119, 1909: Rohwer, U. S. D. A. Bur. Ent. Tech. Ser. 20, Part 6, p. 159, 1913 (in part): Crosby, Ann. Ent. Soc. Amer., vol. 6, p. 156, 1913 (in part): Gahan, Proc. Ent. Soc. Wash., vol. 24, pp. 39, 53, 1922 (in part): Hoffmeyer, Ent. Meddel., vol. 17, pp. 264-265, 1931: Vayssiere, Rev. path. veg. d'ent. agric., vol. 18, p. 185, 1931: Rimsky-Korsakov, Bul. Plant Protect. (Ser. I, Ent.), No. 5, p. 344, 1932: Hellen, Mem. Soc. Fauna Fl. Fenn., vol. 9, p. 190, 1933.

Female—Length, 2.1 mm.; abdomen, 1.1 mm. Ovipositor sheath, 0.7 mm. Outline of head from dorsal aspect somewhat hemispherical, about 1 3/5 as wide as long; vertex slightly higher behind ocelli and rather abruptly defined along occipital carina dorso-medially, minutely transversely rugulose posteriorly; lower genal area very finely aciculate; length of malar space about ½ height of compound eye which is oval and only weakly bulging; occipital carina sharp, evenly arcuate medially above, nearly attaining top of vertex; ocelloccipital line slightly less than ocellocular line or a little more than ½ posterior ocellar line; antennal scrobe moderately deep, poorly defined laterally and especially dorsally; scape equal to combined length of pedicel, ring segment, FI and FII; pedicel oval, less than twice as long as wide but wider and distinctly longer than FI; ring segment about as wide as base of FI; funicular segments about equal, each becoming successively wider; vestiture on head short, fine and sparse but somewhat thicker and stronger on face. Pronotum from above distinctly wider than long, traversed by sharp rugulae medially, sculpture becoming more irregular and less sharp anteriorly and very fine posteriorly, strong flange on anterior dorsal margin with weak emargination; mesopraescutum with fine, weak irregular and numerously interrupted rugulae, more or less shingled at posterior margin; mesoscutum irregularly sculptured anteriorly, becoming weakly shingled posteriorly; axilla with fine, weak oblique or arcuate rugulae; scutellum narrowed anteriorly and truncately rounded, shingled to transverse line, behind with irregular somewhat arched longitudinal or oblique aciculations, almost smooth medially; vestiture on thorax sparse and fine; scutellar hairs (about 4 on each side) forming arched (or irregular) row near lateral margin. Carination of propodeum very irregularly reticulate (often coarse), without regular medium carina; groove below propodeal spiracle moderately deep but not well defined; abdomen compressed, with sparse vestiture; ovipositor evenly arched at base, directed upward.

Color brownish yellow and black. Face entirely brownish yellow to tawny yellow except trace of brown at side of clypeus; gena below and narrow area along dorsal eye margin darker brownish yellow to light brown; remainder of head dark to brownish black; scape and pedicel brownish yellow beneath; remainder of antenna dark brown, flagellum somewhat lighter beneath. Pronotum mostly brownish yellow except flange and side below darker, and indefinite latero-dorsal elongate brown spot (very variable in extent and distinctiveness) on posterior half directed obliquely mesad; remainder of thorax brownish black with indefinite areas on mesopraescutum, on outer surface of mesoscutum and spot beneath front wing base lighter brown, and median oblong-oval spot on scutellum brownish yellow; front coxa yellow infuscated

with brown basally; middle coxa light brown becoming yellowish distally; hind coxa brown; remainder of legs yellow; abdomen dark brown to black except tergum III (apparent first) lighter at base and side, and terga IV to VII inclusive each with pale transverse brown band more conspicuous at side (such markings are usually completely suppressed and abdomen appears entirely black); ovipositor sheath dark brown to black.

Vestiture mostly light brown to very pale, that on dorsum of head and thorax somewhat darker. Stigma oval and without surrounding clouded area except for indications of very pale and indefinite infuscation (Fig. 8); stigmal vein short and somewhat wider at junction with stigma, at most only slightly longer than stigmal sector; proxmial ⅔ of submarginal vein with about 9 strong bristles.

Male—The male of *brevicaudis* as here defined is not known to the writer. That described by Crosby as the male is associated with *americanus*, new species described beyond.

Redescribed from a female, Russia, Feb., 1907, Rodzianko (*Sorbus aucuparia* seed). This is one of the three specimens that were designated by Crosby (1913) as agreeing with Ratzeburg's type, and therefore it has been selected for the redescription.

Type.—Probably at Erbeswalde, Germany.

Type Locality.—Germany.

Hosts.—Seeds of *Sorbus aucuparia* L. in the United States and Europe; *S. scandica* Fr. in Europe. It should be noted here that *M. brevicaudis* is reported from seeds of *Amelanchier ovalis* Med. and *Amelanchier* sp. in Europe (Seitner, 1916; Hoffmeyer, 1931) but it is quite possible that a similar condition is to be found there as in North America; namely, that two species are involved, the one being identical with, or close to our *M. amelanchieris* Cush.

Variations—The ocelloccipital line may be equal to the ocellocular line or ½ the posterior ocellar line, and the malar space may be slightly more or less than ½ the height of the compound eye. Some variation occurs with respect to the sculpture on the pronotum, and especially on the propodeum; rather sharp transverse rugae may be present on the anterior half of the pronotal dorsum, or this area may be weakly sculptured; the carination of the propodeum, which may have at most a weak irregular median carina, sometimes has weak to coarse reticulations with rather regular arcuate carinae laterally. Rarely is the ovipositor sheath nearly as long as the abdomen by actual measurement. The shape of the stigma is usually broadly oval but it may approach that of *americanus*, n. sp., or of *amelanchieris*. The color pattern appears to be rather stable except on the head, pronotum, scutellum and abdomen. Darker individuals have the head entirely black except the face which is brownish yellow and sometimes extensively infuscated. There is a small yellowish brown area just behind the fronto-genal suture on such darker specimens. Lighter individuals have a narrow, yellowish brown circumorbital band that is usually narrowly interrupted on the gena. The pronotum varies from entirely brownish yellow to a condition where there is a definite dark brown to black pattern on the dorsum in the form of a narrow stripe which runs across the anterior dorsal margin and projects obliquely to the posterior margin; each of these oblique lines has a median projection toward the disc.

On other specimens the anterior half of the pronotum may be largely dark brown with the latero-dorsal stripe weak or absent. Sometimes the pronotum may be nearly all brown except a bi-convex posterior yellow band. The brownish yellow on the dorsal surface of the mesoscutum and that on the scutellum may be present or absent. All European specimens examined possess a light marking on the scutellum but of the American specimens only one displays any indication of this spot. The legs are sometimes brownish yellow, especially the hind femur. Color of the vestiture varies from entirely pale to dark on the dorsum of the head, median dorsal surface of the thorax and dorsal area of the abdomen. Usually the body hairs are predominantly pale; that on the dorsal frontal areas of the head laterad of the antennal scrobe is uniformly pale on all specimens examined. The size of individuals seen varies from the dimensions given in the description to the following: Length, 2.7 mm.; abdomen, 1.1 mm.; ovipositor sheath, 0.8 mm. The largest specimens studied are those from Sweden, reared from the seeds of *Sorbus* sp., possibly *S. scandica*. As previously mentioned, the Minnesota specimens reared from *S. aucuparia* are smaller but agree in size and other significant details with Rodzianko's specimens which were reared in Russia from the same host.

Distribution.—Minnesota. Known to occur in Europe as follows: Germany (Eberswalde), Russia (Poltava) and Sweden.

Comments—The specimens here considered as *brevicaudis* conform very closely with the description of Ratzeburg and with the careful redescription of Rodzianko (1908). Material from Sweden (possibly from *S. scandica* seeds) and that from Minnesota cannot be separated except for differences in the average size and the coloration of the scutellum. The same is true of the three females from the series reared by Rodzianko at Poltava (?), Russia.

This study does not yet confirm Crosby's (1909, 1913) opinion that the American specimens reared by him are identical with *brevicaudis*, through future investigations may prove that he was entirely correct. The specimens in question, as well as some from Canada collected at large, appear to the writer to represent a distinct, new species described beyond as *americanus*. Although Crosby stated that he reared his material from the seeds of *Sorbus aucuparia*, it seems to differ in several details from that actually known to have been reared from that host in both America and Europe, and this naturally leads the writer to wonder about the correctness of the specific host identity as originally given by Crosby.

Brevicaudis is very closely related to both *americanus*, n. sp., on the one hand, and to *amelanchieris* Cush. on the other. It is distinguished from *americanus* by coloration, length of ovipositor sheath, color and character of the vestiture, and shape of the stigma. The pronotum is typically tawny or brownish yellow except for the varying dark brown pattern as described. Limited areas of the mesoscutum may be lighter brown and an indefinite spot on the scutellum may be brownish yellow, while the remainder of the thorax is black. *Americanus* is entirely brownish yellow or orange, or the thorax may be entirely dark brown to blackish except lighter at the sides of the pronotum.

In typical *brevicaudis* the ovipositor sheath is usually distinctly shorter than the abdomen and rarely nearly as long, being arched upward especially at the base. The ovipositor sheath of *americanus* is fully as long or a little longer than the abdomen and is typically weakly arched or nearly straight. The vestiture of *brevicaudis* appears to be finer and is predominantly pale except on the center of the vertex of the head and along the median dorsal areas of the thorax where it appears darker. The vestiture of *americanus* is uniformly dark (black) on dorsum. One of the constant features of *brevicaudis* appears to be the entirely pale hairs on the dorsal frontal areas laterad of the antennal scrobe. The stigma is broadly oval to somewhat oblong, but typically not elongate as in *americanus* (*Cf.* figs. 8 and 10, left).

Amelanchieris can be distinguished from this species by one or more of the following features common to *amelanchieris*: Smooth scutellum behind the transverse line; entirely pale, coarser vestiture; ovipositor sheath exceeding the abdomen in length and being evenly and strongly arched upward; lighter or lemon yellow on the face, especially along the lower posterior eye margin on the gena; lemon yellow on the side of the pronotum and on the legs; anterior coxa without infuscation at the base.

The male of true *brevicaudis* as here considered has not been seen by the writer, and he knows of no published records of its occurrence. In this connection, it is interesting to note that Hoffmeyer (1931) figured the stigma of the supposed male but gave no record of material of that sex, while he did record females. Several past workers have suggested that the species may be parthenogenetic and this may well be true. If the male does occur, in all probability it is uncommon and very similar to males of *americanus* and *amelanchieris*.

MEGASTIGMUS AMELANCHIERIS Cushman

Fig. 11

Megastigmus amelanchieris Cushman, Proc. Ent. Soc. Wash., vol. 19, p. 81, (1917) 1918: Gahan, Proc. Ent. Soc. Wash., vol. 24, pp. 39, 52, 1922: Vayssiere, Rev. path. veg, d'ent. agric., vol. 18, p. 185, 1931.

Female—Length, 2.6 mm.; abdomen, 1.0 mm. Ovipositor sheath, 1.0 mm. [By actual measurement, the ovipositor sheath of the type appears to be slightly shorter than the length of the abdomen, but this is not the usual condition.] Outline of head from above similar to that of *brevicaudis*, nearly 1 4/7 as wide as thick; vertex evenly convex except more strongly so on ocellar area, typically transversely rugulose with intermixed shallow setigerous punctures; length of malar space about 1/3 height of compound eye which is broadly oval and not bulging; gena smooth except minutely aciculate anteriorly; occipital carina sharp, evenly arcuate above and nearly attaining top of vertex; ocelloccipital line about same relative length as in *brevicaudis*, being a little less than ocellocular line or slightly less than ½ posterior ocellar line; antennal scrobe deeper than that of *brevicaudis* and more distinctly defined; scape equal to combined lengths of pedicel, ring segment, FI and nearly ½ FII; pedicel a little wider but distinctly longer than FI; funicular segments about equal

and each increasing successively in width; head conspicuously clothed with rather strong hairs especially on vertex and front laterad of antennal scrobe. Pronotum wider than long (about 1/3 wider), outline of side arcuate from above, with flange on anterior dorsal margin at most weakly emarginate, dorsum with rough irregular transverse sculpture on anterior ⅔ and more or less punctate or with very irregular shallow depressions, sculpture finer and less distinct nearer posterior margin; most of mesopraescutum irregularly, arcuately rugulose or shingled; mesoscutum with weaker transverse rugulae and axilla obliquely rugulose, at some angles appearing shingled; scutellum relatively narrow and acutely rounded anteriorly, strongly convex above, shingled to transverse line, behind almost entirely smooth and polished; vestiture on thorax relatively long, strong and rather abundant; scutellar hairs (usually 5 on each side) usually not restricted laterally to single straight row. Propodeum coarsely reticulately rugulose to rugulose-punctate, without complete median carina (or at most with a very irregular, or incomplete median carina), bounded postero-laterally by sharp oblique carinae and with short carinae extending from anterior margin; groove below propodeal spiracle not deep and poorly defined; abdomen compressed (or subcompressed), smooth and polished; vestiture relatively long but not conspicuously abundant; ovipositor rather strongly and evenly arched upward.

Color black and yellow. Head black except face to about middle of inner eye margin and anterior part of gena along ⅔ of posterior eye margin yellow, and spot above eye brownish yellow; scape and pedicel yellow beneath, brown above; remainder of antenna brown except funicular segments yellowish beneath. Pronotum black above except postero-lateral corners brownish (or with rather distinct light brownish or yellow spot), side with large triangular yellow spot surrounded with brown; remainder of thorax black except tegula tawny or brownish yellow mesially, and spot below front wing base brownish; front coxa yellow; middle coxa yellow except brown at base and on posterior surface; hind coxa entirely black except yellowish at distal end; remainder of legs light or lemon yellow. Abdomen dark brown to black except basal sides of tergum III (apparent first) lighter, tergum VIII yellowish medially above (though not always), and sterna castaneous (frequently somewhat circular, indefinite lighter brown spots as sides of median terga especially IV to VI inclusive, becoming successively smaller and less distinct posteriorly); ovipositor brownish black.

Vestiture entirely pale (frequently that on vertex of head, dorsum of abdomen and on ovipositor sheath somewhat dark). Proximal ⅔ of submarginal vein with 10 to 12 strong bristles; stigmal vein shorter than stigmal width, broadened at junction with stigma which is oval (and frequently surrounded by pale infuscation, fig. 11, left); stigmal sector short.

Male—Length, 2.3 mm.; abdomen, 1.0 mm. Head very much like that of female. Pronotum about ⅔ as long as wide, less evenly convex and more extensively smooth on posterior margin and at side; remainder of thorax sculptured as in female but weaker on mesoscutum and axilla. Propodeum reticulate-punctate with only a short median carina posteriorly (variable), and several irregular short carinae originating on anterior margin; abdomen

strongly compressed, smooth and polished except minute, almost imperceptible punctures on terga V to VIII.

Color similar to that of female except side of pronotum entirely yellow which merges with (narrow) transverse dorsal spot of same color on latero-posterior margin; middle coxa almost entirely, and hind coxa more extensively yellow; third abdominal tergum (apparent first) dark brown with faint yellowish brown to castaneous at base; terga IV to VI inclusive brownish black above, laterally each with somewhat conspicuous circular yellowish brown spot at base, followed by posterior brown band; tergum VII mostly dark brown except faint indication of brown spot in position corresponding to location of yellowish spots on preceding segments; tergum VIII largely lighter brown (or brownish yellow); tergum IX and sterna brownish yellow to yellow.

Color and character of vestiture like that of female. Proximal ⅔ of submarginal vein with about 9 to 10 strong bristles; stigma broadly oval, similar in shape to that of female (Fig. 11, right).

Redescribed.—Holotype, female, Pickens, W. Va., (Fred E. Brooks), (Ex seed, *Amelanchier canadensis*, June 1, 1916, R. A. Cushman, Quaintance No. 10930); allotype, with same data as holotype except reared May 28, 1916. Holotype and allotype in the collection of the U. S. National Museum, under type number 20964.

Type Locality.—Pickens, West Virginia.

Hosts.—Seeds of *Amelanchier canadensis* (L.) Medic., *A. laevis* Wieg. X *humilis* Wieg., *A. sanguinea* (Pursh.) DC. and *Sorbus aucuparia*. Undoubtedly other species of *Amelanchier* are hosts in this country. A few larvae have been dissected from the seeds of *A. sanguinea* collected at Cass Lake, Minnesota; the hybrid listed above has been established as host at University Farm, St. Paul, Minnesota (See Part II).

Variations—Female. On some specimens the eyes are larger and more prominent, and the vertex may be more evenly convex and less elevated at the ocellar area. The sculpture is somewhat variable but mostly conforms well with the description; some specimens have prominent rugae on the anterior ⅔ of the pronotal dorsum. Carination of the propodeum is very variable in form and distinctiveness; a strong, complete median carina is usually not present, but a weak incomplete or very irregular carina may be apparent; frequently short longitudinal and lateral oblique carinae originate at the anterior and posterior margins, or the surface may be mostly irregularly reticulate. Sometimes the abdomen is strongly compressed but this does not appear to be the normal condition. The shape of the stigma appears to be fairly uniform throughout the series. The character and color of the vestiture is also fairly constant as described. Color does not vary widely on specimens examined. The spot above the eye may be brown to yellow; the yellow behind the eye on the gena is much more extensive on some than on others. The dorsal yellow spot on the posterior margin of the pronotum may be as extensive as to be united with the yellow of the side except for a very pale brownish line, or the spot may be overcast with brown of varying intensity, and may even be almost absent. The abdomen may be entirely black. In general, the dorsum of the abdomen is dark brown to black with the side below, as well as the sterna, being of a somewhat lighter color; when indefinite lighter spots occur they are usually confined to the side of the median segments (III to V).

Females vary in size as follows: Length, 2.1 mm. to 2.6 mm.; abdomen, 0.9 mm. to 1.1 mm.; ovipositor sheath, 0.8 mm. to 1.0 mm.

Male. Only a single paratype male has been seen in addition to the allotype. It is essentially the same except the yellow at the side of the abdominal tergum VII appears to be more extensive, the posterior terga are darker, and the stigma is more circular.

Distribution.—Minnesota, New Hampshire, New York, Pennsylvania, Vermont, West Virginia.

Comments—Amelanchieris is very closely related to *brevicaudis* structurally but can be distinguished readily from that species by one or more of the following characters: Ovipositor sheath strongly arched upward and equal to the length of the abdomen; scutellum behind the transverse line smooth, polished; body vestiture relatively strong and entirely pale, at least on the thorax; sculpture on the vertex of the head with shallow punctures, that on the pronotum coarse and irregular, and on the mesopraescutum shingled; stigma (Fig. 11) more oval and the stigmal vein expanded at the junction with the stigma; light areas of the head, thorax and legs more nearly lemon yellow and not tawny. Males resemble those of *americanus* but may be separated by their pale vestiture and more extensive yellow color on the head and pronotum.

Megastigmus americanus n. sp.

Fig. 10

Megastigmus brevicaudis Ratz., Crosby, Cornell Agr. Exp. Sta. Bul. 265, pp. 375-377, 1909 (♂; ♀ in part): Rohwer, U. S. D. A. Bur. Ent. Tech. Ser. Pt. 6, p. 159, 1913 (in part): Crosby, Ann. Ent. Soc. Amer., vol. 6, p. 156, 1913 (♂; ♀ in part): Gahan, Proc. Ent. Soc. Wash., vol. 24, p. 39, 1922 (in part): Gahan, Crosby and Leonard, Cornell Agr. Exp. Sta. Mem. 101, p. 975, 1928.

Female—Length, 2.4 mm.; abdomen, 0.9 mm. Ovipositor sheath, 1.0 mm. Head 1½ times as wide as long and somewhat oval in outline from above; vertex evenly convex, finely transversely rugulose, with distinct arched striations continuing onto front; gena smooth; length of malar space about ½ or slightly less than ½ height of compound eye which is oval and more bulging than in *brevicaudis*; occipital carina sharp, almost evenly arcuate above (except weakly angulate medially), nearly attaining top of vertex; ocelloccipital line less than ocellocular line (in about respective proportion of 5 to 7) or less than ½ posterior ocellar line; antennal scrobe somewhat deeper and more definitely defined laterally and dorsally than that of *brevicaudis*; scape about equal to combined lengths of pedicel, ring segment, FI and ⅔ FII; pedicel distinctly longer than FI; funicular segments about of equal length and very gradually increasing successively in width; vestiture on head rather short and fine except on face. Pronotum wider than long, with anterior flange noticeably emarginate, behind which dorsum is inclined on anterior 1/3 or ½ to sharp transverse ridge or carina, remainder of dorsum weakly and irregularly rugulose; mesopraescutum transversely sculptured, rugulae becoming straighter and stronger posteriorly; mesoscutum irregularly rugulose; parapsidal furrow crossed by prominent carinae; axilla finely obliquely rugulose; scutellum trun-

cately rounded anteriorly and rather strongly convex, shingled to transverse line, behind finely longitudinally aciculate; median piece of metanotum narrow and rather high (may be somewhat semicircular); vestiture of thorax similar to that of *brevicaudis* but somewhat longer and stronger; scutellar hairs (3 to 4 on each side) limited to regular, nearly straight row well laterad of median longitudinal line. Propodeum without median carina, coarsely reticulate with short strong carinae on anterior margin and strong lateral arcuate carinae especially posteriorly; abdomen compressed (or subcompressed), with sparse vestiture; ovipositor weakly curved upward.

Color brownish to orange yellow. Head entirely orange yellow except face and gena lighter below, and occiput in part brown (sometimes each ocellus is surrounded in part by brown); scape except distally above and pedicel except basally above, brownish yellow, remainder of these segments and flagellum brown, latter lighter beneath. Remainder of body orange or brownish yellow, darker along anterior propodeal margin; tegula mesially, spot beneath front wing and median piece of metanotum yellowish; front coxa tawny yellow; middle and hind coxae light orange yellow; remainder of legs yellow except somewhat darker on proximal ⅔ of hind femur; base of abdominal tergum III (apparent first) lighter than rest of abdomen which is mostly deep amber; ovipositor dark brown to black.

Vestiture mostly dark except that on face, thoracic pleura and sterna, and legs pale. Proximal ⅔ of submarginal vein with 9 to 10 strong bristles; stigma elongate-oval, (frequently) with weak surrounding infuscation (Fig. 10, left).

Male—Length, 2.1 mm.; abdomen, 0.9 mm. Outline of head oval; vertex evenly convex, finely but distinctly rugulose; antennal scrobe very shallow; scape equal to combined lengths of pedicel, ring segment, FI and fully ⅔ FII; pedicel oval, wider and distinctly longer than FI; funicular segments about equal in length and increase successively in width; occipital carina sharp, evenly arched above; ocelloccipital line with same relative length as in female; vestiture of head moderately long and rather strong. Thorax narrower; pronotum transversely rugulose with sharp median carina; remaining sculpture similar to that of female; that behind transverse line weaker; vestiture rather long and slightly more conspicuous than that of female; scutellar hairs (about 3 on each side) evenly spaced in lateral row. Median carina on propodeum incomplete and weak, lateral arcuate carinae as prominent as in female and converge just behind median piece of metanotum, otherwise propodeum irregularly reticulate-punctate; abdomen compressed, polished, with moderately conspicuous vestiture.

Color yellow, brownish yellow and black. Face to about middle of inner eye margin and lower genal area behind eye yellow; remainder of head brownish black except indefinite yellowish brown spot above eye; scape except distally above and pedicel except basally above yellow, remainder of these segments brown; flagellum light brown, somewhat lighter beneath. Thorax entirely black except spot at side of pronotum, tegula mesially, and spot beneath front wing base yellow; front and middle coxae yellow; hind coxa brown except yellow distally; remainder of legs yellow. Abdominal tergum III (apparent

first) brown medially above, lighter at side; terga IV to VII inclusive dark brown to brownish black above, brownish yellow at sides below (sometimes terga IV to VI each with faint, narrow, transverse brownish band); remaining terga except VIII slightly infuscated basally, and sterna brownish yellow.

Vestiture on dorsum of head, thorax and abdomen dark; remaining vestiture mostly pale. Stigma oval, without surrounding infuscation (Fig. 10, right); proximal ⅔ of submarginal vein with about 9 strong bristles.

Types.—Holotype, female, Ithaca, N. Y., (Ex seed, *Sorbus aucuparia*,* May 4, 1908, C. U. Exp. No. 793). Allotype, Jamesville, N. Y., (C. U. Exp. No. 793, reared May 8, 1909). Types in the collection of Cornell University. Paratypes: 1 female, 5 males, same date as the holotype except reared between April 28-May 29, 1908; 11 females, 8 males, same data as the allotype except reared between May 7-June 5, 1909. Paratypes deposited in the collections of Cornell University and the University of Minnesota.

Type Locality.—Ithaca, New York.

Host.—Seed of *Sorbus* sp.

Variations—Female. Except for the shorter malar space, narrow variation on the ocellar lines and sometimes a shallower antennal scrobe, little variation is noted on the head. The pronotum may have several sharp transverse rugae on the anterior dorsal half instead of a single carina, and the remaining body sculpture may vary somewhat. Carination on the propodeum is very variable. The stigma shows the usual amount of variation in shape. The most striking variation in this species is concerned with the wide range of coloration in the female; the larger percentage of specimens are as described, but some are nearly entirely dark brown to brownish black except the face, side of the pronotum, the legs, usually the tegula, a spot beneath the front wing base, the median piece of the metanotum, and the basal area of the third abdominal tergum, which are lighter brown. The manner in which the brown color advances on the pronotum of this species is different from the condition found in its closest ally, *brevicaudis*. On darker individuals the pronotum found is nearly entirely dark brown above and side lighter brown though not the typical yellowish brown of *brevicaudis*. On some the pronotum has an irregular, indefinitely defined, stripe-like brownish patch that extends along the entire median dorsal area instead of being more nearly uniformly brown. The material examined demonstrates the color gradation between the light and the dark forms as Crosby (1913) pointed out.

Male. Males show similar structural variations as do the females. With respect to color, the darkest specimens may have the pronotum entirely dark, the spot above the eye may be absent, and the yellow on the gena may become reduced or brownish. The legs may appear light brownish. Usually, however, the side of the pronotum has a yellow spot, and lighter individuals have a narrow transverse spot of the same color on the latero-dorsal posterior margin. A single male from Jamesville, N. Y., has the entire side of the pronotum and the prepectus yellow, and superficially resembles the male of *amelanchieris*.

Distribution.—New York, Canada (Ontario).

* Specific identity of host in need of confirmation.

Comments—Crosby (1909, 1913), who studied Ratzeburg's type, was of the very definite opinion that our American specimens reared from the seeds of *Sorbus*, and which are so variable in color, are identical with *brevicaudis* Ratz. It is certain that this species does occur in America in the seeds of *S. aucuparia*, but the American speciemns that were before Crosby do not appear to belong to that species because they exhibit several differences which are not common to specimens of *brevicaudis* from either Europe or America that have been available for study. In spite of the fact that dark individuals of *americanus* are difficult to separate from *brevicaudis* there appear to be sufficient differences between them to permit distinguishing between the two species. The present opinion of the writer is that darker individuals of *americanus* are extreme color variants of the species and that they merge superficially into *brevicaudis*. For the time being this American form as defined here might better be regarded as a distinct species, pending further study. Future investigations may prove that Crosby was entirely correct in his view that this species and *brevicaudis* represent one and the same very variable species, but until this can be ascertained positively it is felt that they should be kept apart.

Crosby (1909, p. 375) stated or inferred that his Ithaca material was reared from the seeds of *S. aucuparia*, but later in his revisionary work (1913, p. 157) he was indefinite with respect to the species of *Sorbus* from which the specimens in question were reared. Much of his original material has been critically examined and, as noted above, found to differ from specimens actually known to have been reared from *S. aucuparia* in this country or abroad. It therefore becomes apparent that the original host species given by Crosby is open to some question; possibly the American specimens were reared from a native species of *Sorbus*.

Typical females of this species have the body entirely brownish yellow or orange and can be separated easily from *brevicaudis* which has at least the mesothorax, metathorax and abdomen almost entirely black. In addition to the slight differences in coloration as noted for the head and pronotum, dark individuals of this species may be separated from *brevicaudis* by one or more of the following characters: Possession of an almost straight or weakly curved ovipositor sheath as long as or longer than the abdomen; uniform dark vestiture on the dorsum of the body and on the dorsal area of the front laterad of the antennal scrobe; elongate-oval stigma. In addition, the dorsum of the pronotum in *americanus* is usually crossed by a prominent carina, and the outline of the abdomen of dried specimens appears less broadly ovate from the lateral view.

There seems to be no reason for confusing this species with *amelanchieris*. Light females may, however, be confused easily with those of *hoffmeyeri*, but, among other differences, that species has the ovipositor sheath distinctly longer than the abdomen and lacks the prominent sculpturing on the pronotum. Males are sometimes difficult to distinguish from those of *amelanchieris*, but in the latter species the vestiture is pale.

The affinities of *americanus* with *brevicaudis* have been made obvious. On the other hand, the female seems to show some affinity with the female of

physocarpi, with which there is probably a closer relationship than is shown by any other known species of the *brevicaudis* group.

MEGASTIGMUS ACULEATUS (Swederus)
Fig. 12

Pteromalus aculeatus Swederus, Kongl. Vet. Acad. Handl., vol. 16, p. 221, 1795 (♀).

Megastigmus transversus Walker, Ent. Magaz., vol. 1, p. 117, 1833: Reinhard, Berl. ent. Ztg., vol. 1, p. 76, 1857: Rondani, Boll. Soc. ent. ital., vol. 4, p. 45, 1872.

Torymus (*Megastigmus*) *collaris* Boheman, Kongl. Vet. Acad. Handl., p. 332, (1833) 1834 (♀, ♂).

Torymus punctum Forster, Beitr. Monog. Pteromal., p. 31, 1841.

Megastigmus collaris (Boh.) Walker, List Hymen. Insects Brit. Mus., Pt. 1, p. 14, 1846: Mayr, Verh. k.-k. zool.-bot. Ges. Wien, vol. 24, p. 137, 1874: Wachtl, Wien, ent. Ztg., vol. 3, pp. 38-39, 214, 1884; Wien. ent. Ztg., vol. 12, pp. 24-25, 1893; Centralbl. f. d. ges. Forstw., vol. 19, p. 7, 1893: Riley, Proc. Ent. Soc. Wash., vol. 2, pp. 361-362, 1893: Morley, Cat. Brit. Chalcid., p. 9, 1910: Laidlaw, Scot. For. Jour., vol. 45, p. 190, 1931: Coulon, Bul. Soc. Sci. nat. Elbeuf, vol. 49, p. 76, 1931.

Megastigmus flavus Forster, Verh. naturh. preuss. Rheinl. u. Westph., vol. 16, p. 109, 1859.

Megastigmus aculeatus (Swed.) Thomson, Hymen. Scand., vol. 4, Pt. 1, p. 63, 1875: Cameron, Trans. Ent. Soc. Lond., p. 118, 1879: Dalla Torre, Cat. Hymen., vol. 5, p. 285, 1898: Rodzianko, Bul. Soc. Imp. Nat. Moscou, vol. 21, p. 599, 1908: Schmiedeknecht, Gen. Insect., fasc. 97, p. 119, 1909: Crosby, Cornell Agr. Exp. Sta. Bul. 265, p. 377, 1909 (in part); Ann. Ent. Soc. Amer., vol. 6, p. 165, 1913. Gahan, Proc. Ent. Soc. Wash., vol. 24, pp. 39, 53, 1922: Gahan, Crosby and Leonard, Cornell Agr. Exp.. Sta. Mem. 101, p. 975, 1928: Hoffmeyer, Ent. Meddel., vol. 17, pp. 265-266, 1931: Rimsky-Korsakov, Bul. Plant Protect. (Ser. I, Ent.), No. 5, p. 344, 1932: [Yano], Iconog. Insect. Japonicorum, p. 352, 1932: Hellen, Mem. Soc. Fauna Fl., Fenn., vol. 9, p. 191, 1933.

Megastigmus cynorrhodi Perris, Ann. ent. Soc. Fr., vol. 6, p. 222, 1876: Dalla Torre, Cat. Hymen., vol. 5, p. 286, 1898: Schmiedeknecht, Gen. Insect., fasc. 97, p. 119, 1909: Laidlaw, Scot. For. Jour., vol. 45, p. 191, 1931.

Megastigmus collaris var. *flavus* (Först.) Mayr, Verh. k.-k. zool. bot. Ges. Wien, vol. 24, p. 138, 1874: Wachtl, Wien. ent. Ztg., vol. 12, p. 28, 1893; Centralbl. f. d. ges. Forstw., vol. 19, p. 10, 1893: Laidlaw, Scot. For. Jour., vol. 45, p. 190, 1931.

Megastigmus aculeatus var. *flavus* (Först.) Dalla Torre, Cat. Hymen., vol. 5, p. 285, 1898: Hoffmeyer, Ent. Meddel., vol. 17, p. 265, 1931.

Female—Length, 3.1 mm.; abdomen, 1.4 mm. (Abdomen somewhat contracted). Ovipositor sheath, 3.9 mm. Outline of head from above semicircular, about 1 4/7 as wide as long; vertex medially depressed, finely transversely rugulose becoming aciculate on orbit and temple, coarser on ocellar area and front; length of malar space fully ½ (nearly 3/5) height of compound eye which is broadly oval and slightly bulging; gena nearly entirely smooth; occipital carina sharp, attaining top of vertex, broadly arched above but somewhat weakly angulate latero-dorsally and laterally; ocelloccipital line only a little less than ocellocular line or ½ posterior ocellar line; antennal scrobe moderately deep and attaining anterior ocellus, defined laterally and dorsally by weak rugae; scape extending well out of antennal scrobe, equal to combined lengths of pedicel, ring segement, FI and nearly ½ FII; pedicel

about as wide as FI and subequal to it; funicular segments of nearly equal width throughout, FI very slightly shorter than FII, both nearly twice as long as wide; remaining funicular segments about equal to FI; head rather uniformly clothed with relatively short hairs except longer on face. Pronotum fully 3/4 as long as wide, with deeply emarginated flange on anterior dorsal margin, dorsum traversed by several distinctly separated sharp ridges or rugae; mesopraescutum with sharp, transversely arched, irregular rugae on anterior half becoming somewhat straighter posteriorly, continuing onto mesoscutum which is more irregularly transverse rugulose; rugulose on axilla strongly arcuate; scutellum truncately rounded on anterior margin, anterior 2/3 with irregular rugulae, at certain angles appearing shingled; transverse line indistinct, area behind longitudinally striate or punctate (or coarsely aciculate); vestiture on thorax stiff but relatively fine, evenly distributed on pronotum; scutellar hairs (about 4 to 6 on each side) restricted to irregular row well laterad of median line. Propodeum coarsely rugulose (reticulate) along anterior margin, followed by somewhat transverse ridge, and with distinct lateral arcuate carinae enclosing oblique rugulae from median posterior margin and two short median longitudinal ridges (complete median carina rarely present; on some the transverse ridge and lateral carinae together appear as strong arcuate carinae enclosing radiating rugulae from posterior margin, but the sculpture is variable); groove below propodeal spiracle somewhat shallow and traversed by rugae; abdomen (usually) compressed; ovipositor evenly arched at base, directed upward.

Color mostly brownish yellow with brown to black markings. Face and gena yellow; head above light brownish yellow except ocelli partly surrounded with black; remainder of ocellar area as well as that extending slightly into antennal scrobe, and spot on posterior area of temple adjacent to occipital carina, brown; occiput dark brown (to black); proximal 2/3 of scape and pedicel yellow beneath; remainder of antenna mostly dark brown. Pronotum light brownish yellow becoming lighter yellow along posterior margin; mesonotum predominantly brownish yellow or amber fading to lighter brownish yellow (or yellow) along ventral and posterior margins of mesoscutum, posterior area of mesopraescutum, inner angle of axilla and extreme lateral area of scutellum; anterior margin of mesopraescutum and outer 2/3 of axilla dark brown or brownish black; metanotum with yellow median piece, remainder brownish yellow and dark brown; pleura, and mesosternum partly brownish yellow, latter with much brown along longitudinal median area; coxae and remainder of legs tawny to brownish yellow except front tarsus and distal segments of other tarsi brown. Propodeum dark brown to black except latero-posterior margin brownish yellow; abdominal tergum III (apparent first) mostly light amber; yellow at side of tergum IV projects antero-dorsad as median transverse brownish yellow band (which may be narrowly and faintly interrupted or constricted at median dorsal line), remainder of tergum brown or amber; terga V to VII inclusive like IV but amber pattern paler and less extensive successively caudad on each; distal terga mostly light brownish yellow with narrow black mark at base of circus; sterna amber; ovipositor sheath black.

Vestiture on scape and pedicel above, dorsum of head, thorax and abdomen, distal end of front femur, row on outer surface of front tibia, and that on ovipositor sheath, dark; remaining vestiture mostly pale. Proximal ⅔ of submarginal vein with about 12 strong bristles; stigma oval, without surrounding infuscation (Fig. 12, left); stigmal sector relatively short; stigmal vein (usually) narrow, shorter than stigmal width (sometimes very much shorter).

Male—Length, 2.7 mm.; abdomen, 1.4 mm. Head similar to that of female; length of malar space about ½ height of compound eye which is oval and moderately prominent; occipital carina attaining top of vertex, somewhat more evenly arched medially above; antennal scrobe moderately deep; scape about equal to combined lengths of pedicel, ring segment, FI and 1/3 FII; pedicel oval, about 4/5 as long as FI which is fully twice as long as wide; funicular segments throughout about equal in width and length. Pronotum nearly as long as wide, or quadrate in outline from above, with fewer transverse rugae on dorsum; remainder of sculpture on thorax very similar to that of female; scutellum narrower, with weak longitudinal striations behind transverse line. Propodeum with irregular carination anteriorly and two incomplete longitudinal carinae (one on either side of median line), bounded laterally by irregular arcuate carinae enclosing reticulate-punctate area (except for few weak transverse rugulae); abdomen compressed, smooth and polished except very fine aciculations on some posterior terga.

Color pattern similar to that of female. Flagellum castaneous, faintly lighter beneath; yellow of head, thorax and legs more uniformly light brownish or tawny. Abdominal tergum III (apparent first) brown, somewhat lighter above; tergum IV with brownish yellow spot at basal side, remainder dark brown; terga V and VI each on posterior dorsal margin with broad transverse dark brown band which becomes narrow and very pale amber at sides, remainder of these terga brownish yellow; tergum VII brown except anterior median dorsal area and side below, as well as remaining terga and sterna, brownish yellow.

Color and character of vestiture much like that of female. Proximal ⅔ of submarginal vein with about 9 to 10 strong bristles; stigma broadly oval or nearly circular and relatively large (Fig. 12, right); stigmal vein much shorter than stigmal width.

Redescribed from a female, Jamaica Plain, Mass., (Seed of Rosa sp., at Quarantine, May 25, 1920, H. L. Sanford, F. H. B. No. 36397); and a male, Ithaca, N. Y., (May 9, 1911, C. U. Exp. No. 804). Female in the collection of the University of Minnesota; male in the collection of Cornell University.

Type.—Its location, if extant, is unknown.

Type Locality.—"Uplandia," Sweden.

Hosts.—Seeds of *Rosa* spp. During the course of this study, specimens reared from, or associated with the following species of *Rosa* were examined from various parts of the world: *R. medwedewii* (Caucasus); *R. rugosa* Thunb. (Germany and U.S.S.R.); *R. davurica* Pall. (U.S.S.R.); *R. alpinia* L. (= *pendulina* L.) (France and Switzerland); *R. jundzillii* Bess. (U.S.S.R.); *R. kamtschatica* Reg. (= var. of *rugosa*) (U.S.S.R.); *R. mollis* Smith (U.S.S.R.). In addition, Nikol' skaya (1934, p. 130) reported *R. cinnamomea* L. (= *pendulina* ?). Possibly several American members of the genus *Rosa*

are hosts of this species. It is possible that Crosby reared his specimens from the seeds of a cultivated rose. All records in the literature referring to *aculatus* (or its synonyms) as being parasitic on other rose infesting insects are entirely erroneous. Material recorded from the seeds of *Evonymus* and *Rhamnus* has been seen, but such records should have confirmation.

Variations—Female. Little significant variation is noted among the American specimens. The vertex is usually weakly sculptured or nearly smooth. Often the occipital carina is evenly arcuate above. The dorsum of the pronotum may be traversed by only two or three rugae as in the male. Considerable variation is noted in the shape of the stigma; sometimes it is more constricted below the stigmal sector and the stigmal vein may be widened at the junction with the stigma. Carination on the propodeum is not extremely variable although the transverse ridge may extend more obliquely laterad from the median anterior margin; a median carina may be present between the two longitudinal carinae but it is no stronger; sometimes the arcuate lateral carinae may appear circular. Exotic specimens of this species examined show a greater degree of structural variation than do the American specimens with respect to the stigma, propodeum, and ovipositor. German specimens reared from *R. rugosa* have the stigma shaped somewhat like that of *nigrovariegatus* Ashm. The length of the ovipositor varies, as does the carination on the propodeum, depending on the host.

The ocelli may be entirely surrounded with black which may be continuous between them; or the ocellar area may be mostly light colored. Frequently the brown spot on the temple is entirely absent, or very deep and extends to the eye margin. Light brown may predominate on the vertex. Much variation in intensity of the abdominal pattern occurs; the appearance may be entirely brownish or golden yellow except for the pale amber posterior band on terga IV to VII inclusive, and the dark dorso-basal patches may be so reduced as to be imperceptible. When the abdomen is abnormally contracted, the overlapping amber bands may give a very dark amber appearance dorsally on the median terga. A light female, which has the host data "Seed of Evonymus," exhibits no structural variations but the dorsal outer $\frac{2}{3}$ of the axilla is yellowish brown and not black, and in this respect closely resembles certain females from China. Much color variation is noted among the foreign material examined. Some of the specimens are mostly dark brown, especially on the posterior surface of the head, anterior dorsal surface of the pronotum, most of the remainder of the thorax and the abdomen. From the darkest, all intergradations to the lightest specimens seem to occur. Since a number of host species are involved, it would seem to indicate that effect of host is one of the important factors responsible for such variations. Future study will probably show that this species is like *nigrovariegatus* in extent of color variation. That the extent of structural variation is similar to that found in *pinus* Parf. is shown by the fact that the form reared from the seeds of *R. multiflora,* and recognized beyond as a variety, is comparable to that form of *pinus* reared from the seeds of *A. grandis*.

Distribution.—Massachusetts, New York. The species is known to occur in France, Germany, Russia (Moscow, Gagri, Tiflis), Switzerland (Geneva), Iran, China (Peking, Tien Tsin) and Africa (French Somaliland).

Comments—Aculeatus is very closely related to *nigrovariegatus* Ashm. but may be separated readily from that species by the possession of an ovipositor sheath distinctly longer than the body (except its variety), by lacking a prominent infuscation of cloud surrounding the stigma, which is typically more regularly oval, and by having the outer dorsal ⅔ of the axilla black (rarely lighter). Males may be distinguished by the lack of a cloud about the stigma, which is more nearly circular, and by the black color on the axilla; the color character is, however, useful only in differentiating between typical *aculeatus* males and the lighter specimens of *nigrovariegatus*. The general coarseness of the body and the longer, more conspicuous vestiture, which is often predominantly pale on the mesothoracic dorsum, are characteristics of *nigrovariegatus*, and will assist in separating dark males of that species.

As suggested by Crosby (1913, p. 160), this species was probably recently introduced; its known occurrence in America at present is only along the Atlantic Seaboard. The American males of typical *aculeatus* are relatively uncommon, resulting in the ratio of males to females being very much lower than that for *nigrovariegatus*. This suggests the strong possibility that the species, or certain forms of it, may be not only capable of reproducing parthenogenetically, but that it may do so normally, in which case thelytoky would seem to be most probable.

MEGASTIGMUS ACULEATUS var. NIGROFLAVUS Hoffmeyer
Fig. 13

Megastigmus aculeatus (Swed.), Weiss, Jour. Econ. Ent., vol. 10, p. 448, 1917: Vayssiere, Rev. path. veg. d'ent. agric., vol. 18, p. 185, 1931.

Megastigmus aculeatus var. *nigroflavus* Hoffmeyer, Ent. Meddel., vol. 16, p. 324, 1931.

Megastigmus collaris var. *nigroflavus* Laidlaw, Scot. For. Jour., vol. 45, p. 190, 1931. (Variety and combination incorrectly credited to Yano).

Female.—Differs from typical *aculeatus* in the following respects: Usually smaller in size; thoracic dorsum more evenly convex, with weaker sculpture and shallower parapsidal furrow; stigma more broadly oval, usually somewhat angulate on outer and inner margins (Fig. 13, left); carination on propodeum more circular laterad of median line and not quite as coarse; ovipositor sheath about as long as body, sometimes longer but not equal to that of typical *aculeatus;* abdomen frequently not noticeably compressed, or only subcompressed.

Color like that of typical *aculeatus* but frequently black below eye along fronto-genal suture; black spot on temples usually attaining posterior eye margin; parapsidal furrow (and furrow between axilla and scutellum) most often dark brown, at least anteriorly; pleura usually brownish; abdomen with brown and amber pattern more intensified dorsally; stigma sometimes surrounded by narrow inconspicuous or pale infuscation.

Variation in size of females is as follows: From *R. multiflora;* length, 1.7 mm. to 3.0 mm.; ovipositor sheath, 1.5 mm. to 3.2 mm. The female from *R. gallica* has a length of 3.1 mm. and the ovipositor sheath is 3.6 mm.

Males—Males are lighter in color and more sharply sculptured. They appear to be indistinguishable from those associated with typical *aculeatus* females, except for minor differences. The following points should be noted in comparison: Transverse brownish yellow bands on dorsum of abdomen frequently wider and more conspicuous; dark brown on tergum VII in general appears to be less extensive, often being reduced to more or less latero-dorsal spots; stigma frequently surrounded by narrow inconspicuous infuscation (Fig. 13, right) and its mesal margin often weakly angulate.

Types.—Holotype (female) and allotype in Hoffmeyer's collection, Copenhagen, Denmark. They are said to be preserved in Canada balsam and have the following data: Japan (locality unknown), reared between June 28 and Sept. 22, 1928.

Type Locality.—Japan.

Hosts.—Seeds of *Rosa multiflora* Thunb., *R. gallica* L. and *Rosa* sp.

Distribution.—New Jersey, Virginia, Japan (Yokohama), Russia (Saratow).

Comments—Superficially, this variety appears to be intermediate between *nigrovariegatus* and typical *aculeatus*. However, it is easily distinguished from the former of these by the absence of a wide, distinct cloud surrounding the stigma and by the presence of black on the dorsal outer $\frac{2}{3}$ of the axilla. The cloud about the stigma may be relied upon to separate any dark males of *nigrovariegatus* when color pattern on the axilla is of no value. From typical *aculeatus* females of this variety may be separated by one or more of the following characters: Dark, shallow parapsidal furrows; somewhat broader, shorter stigma; ovipositor sheath typically at most only a little longer than the body length (rarely nearly as long as in typical *aculeatus*).

Further study may show that this variety should be treated as a subspecies. Does typical *aculeatus* produce progeny like *nigroflavus* when confined to known hosts of this variety? Hoffmeyer had before him over 800 females and 25 males reared from the seeds of *R. multiflora*, and the writer has examined numerous specimens reared in this country from the same host. In general, the combination of characters given for separating it from typical *aculeatus* appear to hold. A female from *R. gallica* is identical with individuals from *R. multiflora* except for a slightly longer ovipositor sheath. A careful rechecking of exotic specimens listed under *aculeatus* in this paper may show that several should be referred to this variety.

Nigroflavus was introduced into this country in the seeds of *R. multiflora*, said to be from Japan; it was first reported in New Jersey by Weiss (1917), infesting these imported seeds.

MEGASTIGMUS NIGROVARIEGATUS Ashmead
Fig. 14

Megastigmus nigrovariegatus Ashmead, Colo. Biol. Ass'n., Bul. 1, p. 26, 1890 (♀ only): Cockerell, N. Mex. Agr. Exp. Sta. Bul. 15, p. 69, 1895: Dalla Torre, Cat. Hymen., vol. 5, p. 287, 1898: Cockerell, Trans. Kans. Acad. Sci., vol. 26, 214, 1899: Schmiedeknecht, Gen. Insect., fasc. 97, p. 119, 1909: Crosby, Ann. Ent. Soc. Amer., vol. 6, p. 158, 1913 (♀, ♂): Gahan, Proc. Ent. Soc. Wash., vol. 24, pp. 40, 53, 1922: Gahan, Crosby and Leonard, Cornell Agr. Exp. Sta. Mem. 101, p. 975, 1928:

Vayssiere, Rev. path. veg. d'ent. agric., vol. 18, p. 185, 1931: Britton, Conn. Geol. & Nat. Hist. Surv. Bul. 60, p. 137, 1938.

Megastigmus aculeatus (Swed.), Crosby, Cornell Agr. Exp. Sta. Bul. 265, pp. 368, 377, 1909 (in part).

Megastigmus nigrovarietus Laidlaw, Scot. For. Jour., vol. 45, p. 191, 1931 (*lapsus calami*).

? *Megastigmus* sp. (1), Riley, Proc. Ent. Soc. Wash., vol. 2, p. 362, 1893.

Female.—Length, 3.2 mm.; abdomen, 1.5 mm. Ovipositor sheath, 2.5 mm. Head similar to that of *aculeatus*, about 1 3/7 as wide as long; vertex depressed, with fine transverse rugulae becoming reticulate along dorsal margin of eye; ocellar area smooth and polished; length of malar space little less than ½ height of compound eye which is oval and moderately prominent; occipital carina attaining top of vertex, (usually) somewhat more angulately rounded latero-dorsally than in *aculeatus*; ocelloccipital line slightly less than either ocellocular line or ½ posterior ocellar line; scape equal to combined lengths of pedicel, ring segment, FI and about ½ FII; pedicel wider and slightly longer than FI; FII apparently only slightly longer than FI or FIII; otherwise all funicular segments approximately same length and at most very gradually increasing in width distally; vestiture on head rather strong, fairly evenly distributed. Pronotum from above only slightly wider than long with flange on anterior dorsal margin weakly emarginate, and dorsum traversed by irregular rugae and distinctly separated transverse ridges; mesopraescutum and mesoscutum with sculpture similar to that of *aculeatus*; axilla more or less finely longitudinally aciculate or with arched longitudinal striations (sometimes appearing shingled); scutellum to transverse line largely reticulate-rugulose (or shingled), behind indistinctly or weakly sculptured (except frequently punctate or reticulate); vestiture relatively long and strong. Propodeum mostly reticulate-punctate enclosed by lateral (or oblique) arcuate carinae with suggestion of transverse ridges as in *aculeatus*, but sculpture throughout weaker and less regular, without median carina (weak or irregular median carina may be present); abdomen compressed.

Color brownish yellow, brown and black. Head mostly dark brown except lateral facial area and that continuing dorsad as broad brownish yellow stripe along anterior and dorsal eye margins (dark brown or black color of head often confined to ocellar area and occiput); scape and pedicel yellowish brown beneath, (often distinctly yellow) transverse band, anterior margin of which is biconvex or deeply incised medially; remainder of pronotum brownish yellow except side lighter yellow above and brown below; mesopraescutum largely dark brown on anterior ⅔, becoming brownish yellow behind; mesoscutum and outer angle of axilla dark brown; metanotum with median piece, and remainder in part, yellowish; remainder of thorax mostly brown; front coxa infuscated with brown basally and on posterior surface and brownish yellow distally; middle and hind coxae mostly brown; remainder of legs light brownish or tawny yellow except anterior surface of hind femur somewhat darker. Propodeum dark brown to black; abdominal tergum III (apparent first) brown at base, lighter at side and on posterior margin; tergum IV mostly

brown above with pale spot at side; remaining terga each mostly yellowish brown with posterior amber border which is greatly reduced or absent on posterior terga; sterna brown; (general color of abdomen is usually brownish yellow to light castaneous); ovipositor sheath black.

Vestiture on face, thoracic pleura, anterior lateral corner of pronotum, legs and abdomen beneath, mostly pale; remaining pubescens largely dark. Wing hyaline except at stigma; proximal ⅔ of submarginal vein with about 8 to 11 strong bristles; stigmal vein relatively short, expanded at junction with stigma and only slightly longer than stigmal sector; stigma dark, somewhat oval to quadrate being typically angulate on mesal margin and surrounded by wide, distinct clouded area (Fig. 14, left).

Male—Length, 2.9 mm.; abdomen, 1.4 mm. Shape, conformation and sculpture of head like that of female except somewhat coarser on vertex; length of malar space not quite ½ height of compound eye; occipital carina sharp, broadly rounded above and attaining top of vertex; ocelloccipital line slightly more than ocellocular line or ½ posterior ocellar line; funicular segments about equal in length, each about twice as long as wide, distal segments increasing but slightly in width; otherwise antennal segments much like those of female. Pronotum as viewed from above with lateral outline convex (but sometimes nearly straight, side of pronotum being almost flat and angulate with dorsum), and transverse sculpture on dorsum irregular but forming two rather distinct transverse median ridges; remainder of thorax sculptured as in female but less regular on posterior area of mesopraescutum and somewhat less distinctly reticulate-rugulose on scutellum. Propodeum more extensively reticulate-punctate than in female, but lateral arcuate carinae present and median carina (frequently entirely absent) broadly interrupted at its middle; abdomen moderately compressed, smooth and polished except for indistinct transverse aciculations on median terga.

Color of head similar to that of female described, but lower genal area and stripe extending dorsad along ⅔ posterior eye margin brownish yellow; antenna dark brown to black. Dorsum of pronotum brownish yellow anteriorly with narrow wedge-shaped brown area which has its apex directed toward posterior margin, and with posterior transverse yellow area somewhat less distinct than in female; rest of thorax mostly brownish yellow except metapleurum and propodeum dark brown or black, with ventro-posterior margin of metepisternum and posterior margin of propodeum lighter; high coxa nearly entirely, posterior half of middle coxa, and posterior surface and base of front coxa, dark brown; remainder of legs mostly light to dark brown. Abdominal tergum III (apparent first) blackish brown medially above, brownish yellow at side; terga IV to VII inclusive nearly entirely brownish black except indication of yellowish brown at extreme side, especially on VI and VII; terga VIII and IX, and visible sterna, light brownish yellow.

Vestiture denser and longer, similar in color except that on dorsum of mesothorax mostly pale (variable) in addition to that noted on female. Proximal ⅔ of submarginal vein with about 8 to 11 strong bristles; stigma large, very dark, with broad surrounding clouded area (Fig. 14, right); stigmal vein short.

Redescribed.—Lectotype, female, Greeley, Colo., bearing "Type No. 2.32, U.S.N.M." in addition to a small white "type" label. Lectotype in the collection of the U. S. National Museum. Male redescribed from the neallotype, Minneapolis, Minn., April 16, 1939, H. E. Milliron (Reared from seed, *R. rugosa*, between May 20-24, 1939); specimen in the collection of the University of Minnesota.

Crosby first described the male of this species from a series in alcohol, without giving data. Undoubtedly this original series has been examined, but it is impossible to segregate the specimen or specimens with certainty from other such material from Cornell University. Therefore, designation of a lectoallotype is hardly possible.

Type Locality.—Greeley, Colorado.

Hosts.—Seeds of *Rosa acicularis* Lindl., *R. blanda* Ait., *R. california* Cham. & Schlecht., *R. canina* L., *R. engelmannii* Crep. (= var. of *acicularis*), *R. palustris* Marsh., *R. rugosa* Thunb., *R. virginiana* Mill., and many *Rosa* spp. as well as a cultivated hybrid rose.

In listing the specimens of this species examined, Crosby (1913, p. 162) gave, without further comment, the following host data for a single female from Pullman, Wash., June 30, 1898 (C. V. Piper): "Reared from *'Clisiocampa plumalis'* (= *Malacosoma pluvialis* Dyar)." Undoubtedly this is an erroneous host record which has since been accepted in the literature (*Cf.* Rühl, 1914, p. 18). Also, Riley (1893, p. 362) stated that a new species of *Megastigmus* was represented in the U. S. National Museum "by one male and two female specimens from J. L. Zabriskie, Nyack, N. Y., Feb. 6, 1884," and that the species "was reared from the cynipid gall, *Callirhytis scitulus* Bassett." A search of all *Megastigmus* material in the U. S. National Museum revealed a female and a male bearing identical data except for lack of host information; these are very likely two of the three specimens referred to by Riley. They are small, atypical *nigrovariegatus*, and their identity throws all doubt on the correctness of Riley's note.

Variations—It is the opinion of the writer that this is the most variable of our Nearctic species. Only points considered significant in aiding recognition of the species are mentioned in the following notations. Ashmead's type series from Greeley, Colorado and Vancouver Island, British Columbia, closely approach the extreme dark female variants and cannot be regarded as strictly average (typical) for the species.

Female. As is to be expected, the malar space and ocellar lines vary to some extent. The occipital carina is also subject to a noticeable deviation in that it is sometimes evenly arched above, lacking any indication of an angulation latero-dorsally; it is rarely angulately arched dorso-medially. Sometimes small specimens have the pedicel distinctly longer than FI, but on the majority of specimens it is only perceptibly longer at most. Certain individuals may be weakly sculptured especially on the head and pronotum, and much of the sculpture on the mesopraescutum and scutellum appears reticulate. The gena may be indistinctly reticulate below the eye; in fact, most of the area surrounding the eye may be reticulate except behind. Carination on the propodeum is very variable from nearly entirely reticulate-punctate to a condition much like that given in the description. Usually the stigma is as described, but sometimes on small specimens it is broadly oval and lacks the mesal angulation; the surrounding infuscation may be pale and inconspicuous, but this is rarely the condition, having been noted only on small, light specimens. Frequently the vestiture on the dorsum of the mesothorax is intermixed with pale hairs, especially on the scutellum, or the thoracic vestiture

tends to be entirely pale on small, light specimens. Females vary in size as follows: Length, 1.6 mm. to 3.2 mm.; abdomen, 0.7 mm. to 1.5 mm.; ovipositor sheath, 1.2 mm. to 2.6 mm. Most of the specimens approach the dimensions as given in the description.

In coloration there is even more striking variation. Some individuals are entirely orange or light brownish yellow except the scape distally, pedicel above, flagellum and ocellar region partly, which are brown; and the ovipositor sheath is brown to black. Frequently these lighter individuals have the infuscation of brown limited largely to the occiput, area bordering the occipital carina, and the anterior margin of the propodeum; usually the abdomen of such specimens is amber or orange yellow. A female from California has only the antenna and the ovipositor sheath dark brown, the thorax is light brownish yellow except paler on the dorsum of the pronotum and mesothorax, and the abdomen is amber. This represents the extreme light variation. The opposite extreme is represented by specimens which are briefly described as follows: The head entirely dark brown to black except a yellowish brown band extending dorsad from the lower genal area along the anterior and dorsal eye margins; the pronotum entirely brownish black except a wide transverse band on the dorsal posterior margin (on some the anterior margin of this band is distinctly biconvex); the psotero-lateral corner of the mesopraescutum, the inner mesoscutal angle, the inner angle of the axilla, the scutellum anterior to the transverse line except for a circular dark brown spot on the anterior margin, the median piece of the metanotum, a spot below the front wing base, and the tegula, are yellowish brown; the remaining parts of the thorax and the propodeum are brownish black to black; the legs are lighter brown except the posterior surface of the front femur is deeply unfuscated, and the hind femur is brownish black save for the lighter proximal and distal ends; the abdomen is brown with darker spots on the basal side of tergum III, and dark brown on the median dorsal areas of the middle terga. Between the two extremes, as given above, all possible intergrades occur.

Having examined a large number of specimens of this species, the following color description of the female is believed to be more typical of the species; it concerns chiefly the parts that are most variable: Ocellar area, occiput, area adjacent to occipital carina, part of temple behind eye, anterior margin of mesopraescutum, brown to black with remainder of head and thorax mostly orange or brownish yellow except pleura very frequently light brownish; legs tawny to brownish yellow except often infuscated on anterior surface of hind femur; abdomen amber to orange yellow except median dorsal area usually appears darker at least over terga III to V inclusive.

Male. Similar structural variations may occur in the male as those detailed for the female. The sculpture on the thorax is often much more irregular, especially on the mesopraescutum. Small males, like corresponding females, may have very weak sculpture and lack the sharp transverse rugae on the pronotal dorsum. Frequently there is a distinct, complete median carina on the propodeum. The proximal $\frac{2}{3}$ of the submarginal vein may have from 7 to 11 strong bristles, but usually there are 8 to 10. The shape of the stigma

is fairly uniform except that of small males may be distinctly oblong-oval, paler, and have only a slight trace of a surrounding infuscation. The range in size is as follows: Length, 1.6 mm. to 3.2 mm.; abdomen, 0.6 mm. to 1.4 mm.

The color of the vestiture on the thoracic dorsum varies widely. On typical or lighter than typical specimens it is usually predominantly to entirely pale, while it may be entirely dark on blackish specimens.

Extreme color variations occur. Certain small individuals may approximate the lighter females, in which case there is a limited amount of brown on the head, and the abdomen is predominantly brown of varying intensities. In general, males are much darker than females. The darkest males seen are entirely jet black, with the legs brownish black, and the distal abdominal terga (VII and IX) more or less yellowish brown. Between the light and dark extremes, all graduations occur. Most of the specimens examined, however, approach the coloration given in the description.

Distribution.—California, Colorado, Connecticut, Delaware, District of Columbia, Illinois, Indiana, Kansas, Maine, Massachusetts, Michigan, Minnesota, New Hampshire, New York, North Dakota, Ohio, Oregon, Pennsylvania, Utah, Virginia, Washington, West Virginia, Wisconsin, Alaska (Fairbanks), Canada (British Columbia, Vancouver Island, Nova Scotia, Quebec).

Comments—This species is nearest related to *aculeatus*, from which females may be separated readily by the cloud surrounding the stigma, and by the absence of black coloration on the outer $\frac{2}{3}$ of the axilla except on very dark individuals. The ovipositor sheath of *nigrovariegatus* females is almost constant in relative length throughout the series studied, and is distinctly shorter than the entire body length, whereas, that of typical *aculeatus* is distinctly longer than the total body length except in the variety *nigroflavus*. Typical *nigrovariegatus* males can be separated from those of *aculeatus* by the difference in color of the axilla, and by the distinct cloud surrounding the stigma.

Nigrovariegatus also appears to show some structural affinities with *formosus*, n. sp., described beyond. These affinities are shown in conformation of the head, character of the propodeum, coarse sculpture on the pronotum, and the clouded area surrounding the stigma. However, *formosus* appears to be distinctly more closely allied to *albifrons* Walk.

Of our Nearctic species, this is by far the most common and most widely distributed. At present it is known only from North America.

MEGASTIGMUS LARICIS Marcovitch

Fig. 18

Megastigmus laricis Marcovitch, Can. Ent., vol. 46, p. 435, 1914: Rohwer, Can. Ent., vol. 47, p. 97, 1915: Gahan, Proc. Ent. Soc. Wash., vol. 24, pp. 39, 51, 1922: Gahan, Crosby and Leonard, Cornell Agr. Exp. Sta. Mem. 101, p. 975, 1928.

Female—Length, 2.0 mm.; abdomen, 1.0 mm. Ovipositor sheath, 1.3 mm. Head from above hemispherical, about 1 3/5 as wide as long, length of malar

space nearly ½ height of compound eye; vertex evenly convex, mostly smooth and polished anteriorly, with very fine transverse rugulae posteriorly; ocelloccipital line subequal to ocellocular line or slightly more than ½ posterior ocellar line; occipital carina nearly attaining top of vertex, and very weakly angulate above; antennal scrobe very shallow and indistinctly defined; scape about equal in length of pedicel, ring segment, FI and ½ FII; pedicel oval, wider than FI and about equal to FI and ½ FII combined; FI and FII approximately equal; all funicular segments less than twice as long as wide and increase successively in width; vestiture of head fine. Pronotum wider than long, with sharp, rather deeply emarginate flange on anterior dorsal margin, and very fine, irregular transverse rugulae on dorsum; type of transverse sculpture on thorax similar to that of other species *e.g., piceae,* but very fine; scutellum rather strongly convex especially anteriorly, finely punctate on anterior margin followed by somewhat shingled sculpture to transverse line, behind mostly smooth and polished; thoracic vestiture sparse and not conspicuous. Propodeum with delicate arcuate lateral carinae and distinct median carina interrupted medially; groove below more or less circular propodeal spiracle shallow; abdomen compressed (to subcompressed), polished; ovipositor evenly arched upward.

Color black and tawny yellow. Face to middle of inner eye margin, except vertical pale brownish stripe (may be absent) above clypeus, and lower genal area tawny yellow; indefinite spot above eye and temple below adjacent to margin brownish yellow; remainder of head dark brown to black; scape basally and beneath tawny yellow, remainder of antenna light brown but paler beneath. Thorax entirely black except yellow tegula and spot under front wing base brownish yellow; front coxa tawny yellow except indication of pale brown at extreme base; middle coxa brown except yellowish on anterior and distal surfaces; hind coxa black; remainder of legs tawny yellow (except very faint brownish cast on median anterior surface of hind femur of lectotype is noted). Abdomen black except brownish yellow spot at sides of median terga narrowly and indistinctly extending toward median dorsal line; ovipositor sheath dark brown to black.

Vestiture on face, lower genal area, scape distally above, thoracic sterna and pleura, most of legs and abdomen beneath, pale; remaining vestiture mostly darker. Proximal ⅔ of submarginal vein with 7 to 8 conspicuous bristles; stigma oval (Fig. 18, left), without surrounding infuscation; stigmal sector rather long; basal vein pale.

Male—Length, 1.7 mm.; abdomen, 0.7 mm. Shape and sculpture of head and dimensions of antennal segments very similar to female; transverse rugulae on pronotum somewhat more irregular. Median carina on propodeum sharp, complete, somewhat weaker anteriorly; abdomen smooth, polished.

Head colored as in female except yellow on gena and on temple behind eye margin more extensive and lighter. Side of pronotum, especially below, and two indefinite patches on posterior dorsal margin light brown to brownish yellow; thorax otherwise, and legs, colored as in female. Abdominal tergum III (apparent first) brown, lighter at side; terga IV to VII inclusive brown

above, each with darker posterior border and indefinitely shaped yellowish spot at side narrowly extending toward median dorsal line; remaining terga and sterna brownish yellow, basal sterna somewhat darker.

Vestiture of body fine, sparse, colored as in female. Proximal ⅔ of submarginal vein with 7 or 8 conspicuous bristles; stigma somewhat similar to that of female (Fig. 18, right).

Redescribed.—Lectotype, female, Ithaca, N. Y. (Fall, 1913), S. Marcovitch (Ex seed, *Larix laricina*, April, 1914); lectoallotype, same data. Lectotype and lectoallotype deposited in the collection of the University of Minnesota.

Type Locality.—Ithaca, New York.

Host.—Seeds of *Larix laricina* (Du Roi) K. Koch.

Variations—The range of variation in this species is indeterminable because of so little material at hand. Some females have the head more strongly sculptured and the median carina on the pronotum may be branched posteriorly. The stigma is variable in shape, some being narrower than others. Color varies to some extent so that darker females have the gena and temple below almost entirely brown. The pronotal pattern of lighter specimens may be feebly indicated by the presence of varying shades of brown at the side and two indefinite patches of the same general color on the posterior margin of the dorsum. The abdominal markings are much more distinct on some than on others. Females examined vary in size only slightly from the dimensions given in the description.

The chief variation in the male involves color. Yellow around the eye may be complete except for a weak interruption on the dorsal area of the front. The yellowish spots on the dorsum of the pronotum may be reduced, or distinctly yellow and conspicuous. Likewise, the yellow pattern on the abdomen may be either somewhat reduced or appear as brownish yellow. Variation in size of males examined is insignificant.

In the original description referring to the male the following is given: "Whole dorsal aspect of thorax black." Evidently, yellow or light brown on the dorsum of the pronotum in the form of two indefinite spots on the posterior margin is the usual case, and this slight discrepancy in the original description is here noted.

Distribution.—New York.

Comments—The types of this species were reported to be in the collection of Cornell University. The series from there consists of one female and two males; each specimen bears a "type" and a "cotype" label (Cotype, Cornell U. No. 511.1 to 511.3 respectively). These are not in good condition. Since the species was described from a series of 15 females and 12 males, attempts were made to locate the remainder of the type material. A portion of this original type series was contained in the private collection of Professor Marcovitch, and in order to make possible the designation of lectotypes that are in more satisfactory condition than material at Cornell, he has kindly donated to the collection of the University of Minnesota these specimens from which the lectotype and lectoallotype were selected.

None of the specimens examined bear any such date as "July 17, 1914," mentioned in connection with the original description. Professor Marcovitch has informed the writer that the seeds containing larvae were actually collected in the fall (of 1913) and that the adults were reared in April (of 1914) However, there are three females and one male in the collection of the U. S. National Museum bearing what is believed to be a correct date of March 2, 1914, indicating that some of the material was reared earlier. At any rate, it is obvious that "July 17, 1914" does not apply to the type series.

This species is the typical member of the *laricis* group, its nearest relative apparently being the European *M. seitneri* Hoffm. *Laricis* shows affinities with *piceae,* yet it appears to be entirely distinct from that species. The following features common to *laricis* will serve to distinguish it from typical *piceae*: Presence of a median carina on the propodeum; absence of dark infuscation on the face and hind femora; and the absence of a conspicuous amount of dark vestiture on the face. From *tsugae,* this species may be distinguished by the lack of conspicuous yellow spots on the dorsal posterior margin of the pronotum, as well as by the absence of dark infuscations on the middle and hind legs.

Megastigmus melanus n. sp.

Fig. 24

Female—Length, 2.1 mm.; abdomen, 0.9 mm. Ovipositor sheath, 0.9 mm. Head from above more oval than that of preceding species, but also about 1 3/5 as wide as long; length of malar space approximately 2/5 height of compound eye which is oval and only slightly bulging; vertex evenly convex with fine irregular sculpture; gena smooth; occipital carina evenly arched above; ocelloccipital line slightly less than ocellocular line or about ½ posterior ocellar line; antennal scrobe moderately deep, defined laterally by delicate carina, shallow above and scarcely attaining anterior ocellus; scape equal to combined lengths of pedicel, ring segment, FI and about 1/3 FII; pedicel wider and little longer than any other funicular segment; remaining funicular segments of nearly equal length, each increasing successively in width. Thorax comparatively narrow; pronotum wider than long with somewhat thickened flange on anterior dorsal margin weakly indented, and with dorsum weakly sculptured being mostly shingled except two sharp, arched transverse rugae of which the anterior one is broadly interrupted medially; sculpture of mesothoracic dorsum weak, that on anterior area of mesopraescutum irregularly reticulate, behind shingled; parapsidal furrow deep; mesoscutum and axilla with irregular oblique rugulae or aciculations appearing shingled at certain angles; scutellum narrow, acutely rounded anteriorly, shingled to transverse line which is weak and tri-arcuate, and mostly smooth and polished behind transverse line; vestiture of thorax not dense but relatively long and fine. Propodeum without distinct median carina, reticulate-punctate except stronger oblique posterior carinae and fine lateral arcuate carinae; groove below propodeal spiracle shallow; abdomen compressed, with fine vestiture; ovipositor gradually curved upward.

Color black. Head black except face somewhat lighter or brownish black with vague patch below antennal bases and area immediately above mouth at side of clypeus yellowish brown; most of scape yellow except brownish yellow distally above; pedicel brownish yellow beneath; remainder of antenna light brown. Thorax entirely black except indefinite spot below front wing base brown; all coxae black except front and hind coxae lighter distally and middle coxa yellowish on inner surface; remainder of legs and tegula mesially tawny yellow. Abdomen brownish black; ovipositor sheath black.

Vestiture entirely pale. Stigma oval, bent mesad, and without surrounding infuscation (Fig. 24); 9 or 10 conspicuous bristles on proximal ⅔ of submarginal vein.

Male—Unknown.

Type.—Holotype, female, "Ag. Coll. Mich., May 12. [?] 1892," (followed by the number 49). Holotype in the collection of the U. S. National Museum. Right middle leg beyond trochanter and left antenna beyond pedicel are missing.

Type Locality.—Michigan (?).

Host.—Unknown.

Comments—This species superficially resembles *laricis* and to some extent, *brevicaudis* and *amelanchieris*, but apparently it is not closely related to any of them. The almost total absence of yellow body markings, the comparatively narrow thorax, the relatively long, pale vestiture, and the general shingled sculpture of the thorax should serve to distinguish it from all other known members of the genus in our region.

MEGASTIGMUS PICEAE Rohwer
(nec Seitner, 1916)
Fig. 16

Megastigmus piceae Rohwer, Can. Ent., vol. 47, p. 97, 1915: Gahan, Proc. Ent. Soc. Wash., vol. 24, pp. 40, 52, 1922: Hoffmeyer, Ent. Meddel, vol. 17, p. 215, 1930 (?): Escherich, Zeit, f. angew. Ent., vol. 25, p. 366, 1938.

Female—Length, 2.7 mm.; abdomen, 1.3 mm. Ovipositor sheath, 2.3 mm. Head 1⅔ as wide as long; length of malar space nearly ½ height of compound eye which is oval and moderately prominent; vertex convex with transverse rugulae intermixed with shallow setigerous punctures; gena smooth; occipital carina somewhat angulate medially above, almost attaining top of vertex; ocelloccipital line more than ½ ocellocular line or a little less than ½ posterior ocellar line; scape as long as pedicel, ring segment, FI and 1/3 FII together; pedicel distinctly wider and longer than FI; FI and FII nearly equal in length and width, each nearly twice as long as wide; remaining funicular segments well separated and each a little longer than wide. Thorax shining; pronotum wider than long, with transverse rugulae becoming weaker to smooth on posterior margin and without strong or conspicuous flange on anterior dorsal margin; mesopraescutum with strongly arched rugulae on anterior ⅔, becoming smooth on posterior area; sculpture of mesoscutum more or less transverse rugulose, that on axilla oblique being smoother on inner and ante-

rior margins; scutellum anteriorly rugulose-punctate, followed by shingled condition to transverse line, behind mostly smooth (and polished). Propodeum somewhat coarsely reticulate-carinate, with weak median carina only posteriorly (or with very weak irregular median carina), short longitudinal carina on anterior margin, and indications of lateral arcuate carinae; abdomen subcompressed (or compressed), smooth and polished; ovipositor evenly arched upward; vestiture of thorax moderately long and strong, not conspicuously abundant.

Color black and yellow. Face from transverse line just above antennal bases except median brown spot extending onto clypeus, and scape and pedicel beneath mostly brownish yellow (or yellow); remainder of head black, except indefinite spot above eye and lower genal area light brownish; scape distally, pedicel above and remainder of antenna light brown, somewhat paler beneath. Thorax entirely black except tegula mesially yellowish, and indefinite spot beneath front wing base brownish; front coxa yellow distally and on anterior surface, brown at base; middle coxa all brown except lighter distally; hind coxa black; front and middle femora infuscated on ⅔ posterior surface; hind femur brownish black except extreme base and distal ends which are lighter; remainder of legs brownish yellow, (distal) tarsal segments darker. Abdomen black, sterna somewhat lighter; ovipositor sheath mostly dark brown to black.

Vestiture on dorsum of head, antenna, dorsum of thorax and abdomen, ovipositor sheath, posterior surface of front femur and some on front and middle tibiae, black; remainder pale except some on face (most frequently) dark or blackish. Proximal ⅔ of submarginal vein with 11 to 13 conspicuous bristles; stigma without surrounding infuscation, elongate-oval (Fig. 16, left), with stigmal sector long, sharp and nearly equal to stigmal width.

Male—Length, 2.4 mm.; abdomen, 1.2 mm. Dimensions of head and body sculpture similar to that of female; head colored as in female except for absence of brown spot on face and clypeus, and brighter yellow more extensive on gena and temple adjacent to eye margin. Thorax entirely black except brownish spot on side of pronotum anteriorly; coxae and remainder of legs similar in color to those of female except front and middle legs lighter and lack infuscations on posterior surfaces of femora, and brown on hind femur mostly limited to median anterior surface. Abdominal tergum III (apparent first) dark brown; terga IV and VII inclusive each dark brown with yellowish brown spot at side, becoming largest and lightest on terga V and VI; posterior terga and sterna dark brown.

Proximal ⅔ of submarginal vein with about 10 conspicuous bristles; stigma similar to that of female but wider (Fig. 16, right).

Redescribed.—Holotype, female, Crescent City, Calif., P. D. Sergent (Reared, *Picea sitchensis*, April-May, 1914, 10850j Hopk. U. S.); allotype, with the same data except reared April-June, 1914. Holotype and allotype in the collection of the U. S. National Museum under Type No. 19066 U.S.N.M.

Type Locality.—Crescent City, California.

Hosts.—Seeds of *Picea sitchensis* (Bong.) Carr., *P. engelmannii* (Parry) Engelm., and *P. pungens* Engelm.

Variations—Female. Representatives of this species do not show a wide range of variation. Much of the structural differences in the female occur with respect to sculpture, some being more coarsely rugulose across the pronotum, and the posterior part of the scutellum may be more sharply sculptured than usual. The basal funicular segments vary slightly in length. The shape of the stigma and the prominence of the stigmal sector are more variable. The carination of the propodeum, although variable, usually conforms fairly well to the brief description of it; frequently there is present, however, a weak median carina that may be complete, or interrupted, or deviate anteriorly. The legs of some may be nearly entirely tawny yellow, with but little infuscation on the anterior surface of the hind femur. Specimens reared from the seeds of *P. pungens* are generally darker (which tends from the usually more brownish black to deep black) except the legs, and appear to have slightly stronger vestiture. Dark females may have the face and genal area, as well as the front coxa, almost entirely brown. Females examined vary in size as follows: Lenth, 2.5 mm. to 3.0 mm.; abdomen, 1.1 mm. to 1.4 mm.; ovipositor sheath, 2.3 mm. to 2.6 mm.

Male. Males may exhibit the same general structural variations. The face at the side of the antennal scrobe is frequently light brownish yellow. The yellow at the side of the pronotum may be extensive, or reduced or absent. Some specimens may show very faint indications of two light brown spots on the posterior dorsal margin of the pronotum. Lighter specimens have but little infuscation on the legs. Sometimes the abdomen of males has a definite yellow pattern approaching that of its variety described beyond; the anterior sides of terga V and VI especially may be yellow, with yellowish brown less extensive on the sides of IV and VII. On others, the yellowish spots may be absent on terga IV and VII and very obscure on V and VI, or absent on all terga. The stigmal shape is sometimes more circular than described, or noticeably constricted at the junction with the stigmal vein. Males examined vary as follows: Length, 2.3 mm. to 2.7 mm.; abdomen, 1.0 mm. to 1.2 mm.

NOTE.—The lighter areas on specimens freshly killed are decidedly more nearly yellow and not yellowish brown, which is more often associated with older specimens and those at one time preserved in fluid. Therefore, a certain amount of allowance must be made with regard to color.

Distribution.—California, Colorado.

Comments—This species appears to be somewhat closely related to *laricis* from which it can be distinguished by the characters given in comments under that species. It is closely related structurally to *caperatus*, n. sp. described beyond.

Megastigmus piceae var. montana n. var.

Female—Length, 2.4 mm.; abdomen, 1.1 mm. Ovipositor sheath, 2.0 mm. Color of head essentially like that of typical *piceae* except median brown spot on face absent and genal area more extensively yellow or yellowish brown. Pronotum black except large spot on side and two somewhat triangular spots

on dorsal posterior margin, yellow (spot above and at side may be narrowly connected); remainder of thorax and legs colored as in *piceae* except infuscation on anterior surface of hind femur weak or absent. Abdominal tergum III (apparent first) and all sterna dark brown to black; terga IV to VII each black with lateral median yellow spot narrowly extended toward median dorsal line, largest and most conspicuous on terga V and VI; ovipositor sheath dark brown to black. Character and color of vestiture very similar to that of typical *piceae* except only a few blackish hairs on face and lower genal areas.

Male—Length, 1.9 mm.; abdomen, 0.9 mm. Color of head as in typical *piceae*. Pronotum black except most of side (somewhat discolored on type) and two spots on dorsal posterior margin as in female, yellow; remainder of thorax black except tegula, circular spot beneath front wing base, and prepectus in part, yellow; middle coxa more extensively yellow than in typical *piceae*. Abdominal tergum III dark brown above, lighter at side; tergum IV dark brown except circular yellowish spot at side; terga V and VI each with dark brown on anterior and posterior areas, between with transverse yellow or yellowish brown stripe; tergum VII entirely brown; tergum VIII brown at base, otherwise remaining terga and sterna except basal ones, yellowish or light brown.

Types.—Holotype, female, Haugan, Mont., Mar. 17, 1937, G. M. De-Jarnette, (*Picea engelmanni* seed, 21920 Hopk. U.S.); allotype, with same data. Paratypes: 1 female, 1 male, with same data as holotype. Types are in the collection of the U. S. National Museum.

Type Locality.—Haugan, Montana.

Host.—Seeds of *Picea engelmannii* (Parry) Engelm.

Variations—The coloration of the male is subject to some variation; the prepectus of the paratype male is largely yellowish, and there are indications of yellow on the ventral areas of the meso- and metapleura, as well as a very slight indication of light brown on the inner angles of the axillae. The paratype female, which is smaller, has the following dimensions: Length, 1.9 mm.; abdomen, 0.9 mm.; ovipositor sheath, 1.7 mm.

Distribution.—Montana.

Comments—It is possible that this variety, so called, may actually represent a good species. However, no significant structural deviations were found on these specimens that would justify the recognition of a distinct species. Exception to this are the slight difference in shape of the stigma and the smaller size, as compared with typical *piceae*. It is difficult to ascertain the constancy and significance of such differences with so few specimens available for study.

Megastigmus caperatus n. sp.

Fig. 17

Female—Length, 3.1 mm.; abdomen, 1.4 mm. Ovipositor sheath, 2.9 mm. Outline of head from above somewhat hemispherical, slightly more than 1½ as wide as long; gena almost imperceptibly aciculate below; occipital carina evenly arcuate and flanged above, almost attaining top of vertex; ocelloccipital

line slightly more than ½ ocellocular line or a little less than ½ posterior ocellar line; antennal scrobe shallow, poorly defined laterally; scape equal to pedicel, ring segment, FI and ½ FII; pedicel elongate-oval, wider and distinctly longer than FI; ring segment relatively large; FI about twice as long as wide, slightly narrower than following segments; funicular segments except FI all about same length and of nearly equal width. Pronotum wider than long, with narrow but rather deeply emarginate flange on anterior dorsal margin, and dorsum with distinct transverse rugulae which are mostly directed caudad postero-laterally and become weaker behind; sculpture on mesothoracic dorsum similar to that of *piceae* but stronger; scutellum anterior to transverse line mostly shingled, median anterior area behind transverse line punctate to weakly striate laterally; median piece of metanotum rather large and somewhat conically produced at its middle; vestiture not noticeably long, rather sparse. Propodeum mostly coarsely reticulate, elevated and almost evenly convex, without distinct median carina (two rather strong, irregular longitudinal carinae present, being especially strong posteriorly); arcuate lateral carinae weak and very irregular and interrupted; anterior margin directly behind median piece of metanotum with strong arcuate ridge from which oblique carinae extend; propodeal spiracle small, circular, groove below shallow; abdomen compressed, polished; ovipositor evenly curved upward though more strongly arched at base.

Color black, brown and tawny yellow. Face to about middle of inner eye margin and lower region of temple mostly brownish yellow infuscated with brown below eye along fronto-genal suture; remainder of head black except small yellowish brown spot above eye; scape entirely yellow except brownish distally above; remainder of antenna brown except pedicel and ring segment yellowish beneath. Thorax black except tegula yellow; front coxa yellow with slight infuscation at extreme base; middle coxa light brownish yellow except brown on posterior surface; hind coxa black; femora yellow with very faint infuscation on posterior surface of front femur, and on anterior surface of hind femur; remainder of legs tawny yellow. Abdominal tergum III (apparent first) dark brown; terga IV to VI inclusive dark brown with anterior brownish yellow spot on side extending dorsad as median transverse stripe, being most conspicuous on terga V and VI; pattern on tergum VII essentially same except stripe interrupted leaving isolated yellowish spot above; remaining terga and sterna dark brown; ovipositor sheath dark brown to black.

Vestiture on head, thorax and abdomen above, few stronger hairs on tibiae and those on ovipositor sheath, black; remaining vestiture largely pale. Proximal ⅔ of submarginal vein with 10 to 12 conspicuous bristles; basal vein pale; stigma approximately oval, without surrounding cloud (Fig. 17); stigmal vein almost as long as stigmal width.

Type.—Holotype, female, Port Hope, Ontario, May 23, 1895. Holotype is in the Canadian National Collection, Ottawa.

Type Locality.—Port Hope, Ontario, Canada.

Host.—Unknown (possibly a species of *Picea*).

Comments—This species seems to be only distantly related to *specularis*,

though superficially it has resemblance to darker females of that species, from which it may be separated by the longer pedicel, sharper sculpture, shape of the stigma, and a distinctly different and more definitely marked abdominal pattern. Structurally, *caperatus* appears to be very closely allied to *piceae* Rohw., from which it may be separated easily by the yellow markings on the abdomen and the absence of black vestiture on the face. From *piceae* var. *montana* it may be separated by its more robust form and greater dimensions, more strongly elevated propodeum, shape of the stigma, and lack of conspicuous yellow markings on the pronotum.

MEGASTIGMUS TSUGAE Crosby

Fig. 20

Megastigmus sp. C. Riley, Proc. Ent. Soc. Wash., vol. 2, p. 360, 1893.
Megastigmus strobilobius Ratz., Rohwer, U.S.D.A. Bur. Ent., Tech. Ser. 20, Pt. 6, p. 159, 1913 (in part).

Megastigmus tsugae Crosby, Ann. Ent. Soc. Amer., vol. 6, p. 162, 1913: Gahan, Proc. Ent. Soc. Wash., vol. 24, pp. 40, 54, 1922: Hoffmeyer, Ent. Meddel., vol. 17, p. 218, 1930 (?): Escherich, Zeit. f. angew. Ent., vol. 25, p. 367, 1938.

Female—Length, 2.5 mm.; abdomen, 1.1 mm. Ovipositor sheath, 1.8 mm. Head transverse oval from above, about twice as wide as long; length of malar space about 1/3 height of compound eye which is nearly circular in outline; vertex evenly convex with weak sculpture anteriorly and transverse irregular rugulae extending onto orbits and temple posteriorly; occipital carina nearly attaining top of vertex, somewhat angulate medially above, ocelloccipital line about $\frac{2}{3}$ ocellocular line or $\frac{1}{2}$ posterior ocellar line; face minutely rugulose, above clypeus somewhat swollen; gena smooth; antennal scrobe shallow, not defined by distinct carinae; scape relatively short, about equal to combined lengths of pedicel, ring segment and FI; pedicel oval, distinctly longer than FI; FI about equal to FII, both less than twice as long as wide (remainder of antenna missing). Pronotum as seen from above as wide as long and somewhat hemispherical in outline, being noticeably narrower or arcuate anteriorly, its dorsum with weak irregular transverse rugulae; mesopraescutum sculptured much as in other species (except posterior 1/3 on type with more or less longitudinal rugulae); sculpture of mesoscutum and axilla weaker especially on inner angle of latter; scutellum almost as wide as long, its acutely anterior margin not deeply defined, and its surface anteriorly rugulose-punctate, behind almost smooth or with weak transverse sculpture; transverse line somewhat obscure; median piece of metanotum transverse rectangular, rather large but almost concealed by scutellum when viewed from above; vestiture of head and thorax rather short, sparse. Propodeum without median carina, finely reticulate, laterally with arcuate carinae; abdomen polished, with fine, sparse vestiture; ovipositor not strongly arched upward.

Color black and tawny yellow. Face to middle of inner eye margin, lower genal area, vertical line behind and indefinite spot above eye, yellow; remainder of head black; antenna brown except scape and pedicel yellowish brown beneath (segments beyond FII missing). Pronotum with two widely separ-

ated spots on postero-lateral margin of dorsum, side anteriorly, and tegula, yellow remainder of thorax black; front coxa yellow except infuscated basally; middle coxa brown except yellow or yellowish brown on anterior surface; hind coxa black; front femur brownish yellow, basal 2/3 of middle femur infuscated and all hind femur brown except distal end; remainder of legs brownish yellow except hind leg darker. Abdominal tergum III (apparent first) entirely, and sterna, black; remaining terga black except each with median transverse yellow band which becomes wider at side below and successively more extensive on posterior terga; ovipositor sheath dark brown to black.

Vestiture on dorsal body region black, remainder largely pale. Proximal 2/3 of submarginal vein with 11 conspicuous bristles, stigma somewhat rectangular (Fig. 20), without surrounding infuscation; stigmal vein about equal to stigmal width.

Redescribed, female (and one paratype female), ("Western U. S., H. Borries"), Ex *Tsuga mertensiana hookeriana,* Quill VI C. Holotype in the collection of the U. S. National Museum under Type No. 27518 U.S.N.M.; the paratype female is also in the same collection.

NOTE.—The holotype female lacks the following parts: Antennae, right front wing, and ovipositor. The antennal segments beyond FII are also missing on the paratype. The above composite description is, therefore, based on both females. The remarks concerning what remains of the antennae, and those applying to the ovipositor and to color in part refer to the paratype.

Type Locality.—Western United States.

Host.—Seeds of *Tsuga mertensiana* (Bong.) Sarg.

Variations—With respect to the paratype, the following differences may be noted: The rugulae on the posterior 1/3 of the mesopraescutum are not definitely longitudinal in character; most of the scutellum anterior to the transverse line is distinctly shingled; the carinae at the side of the propodeum are not arcuate, but they appear more or less as a reticulation of longitudinal carinae. From certain angles the entire thoracic dorsum may appear shingled.

Comments—Hoffmeyer (1930) has reported this species from *Abies amabilis* from Washington. This record is here not accepted until it can be confirmed by additional rearings.

Megastigmus tsugae var. **heterophyllae** n. var.

Fig. 19

Female—Length, 1.9 mm.; abdomen, 0.9 mm. Ovipositor sheath, 1.2 mm. Much like typical *tsugae* structurally except for smaller size, less quadrate shape of the stigma and the presence of a distinct median carina on the propodeum.

Color black and yellow. Face, gena, temple below, band above eye (nearly completely interrupted with very pale brown on temple), scape except distally above, yellow to light brownish yellow; remainder of antenna brown except pedicel lighter beneath. Pronotum yellow except dorsum with large, semicircular black spot extending caudad from median anterior margin (may

extend to posterior margin on some), and indefinite brownish spot at extreme posterior latero-dorsal margin; prepectus, mesopleurum, metepisternum except black dorsal half, metepimeron, outer surface of mesoscutum, tegula, inner angle of axilla, yellow; scutellum anteriorly with two well separated, poorly defined brown patches, and two more distinct spots of yellowish brown behind transverse line (posterior spots may be contiguous, giving entire area behind transverse line yellowish brown appearance); remainder of thorax black except median piece of metanotum brownish yellow; all coxae yellow except hind coxa infuscated at base; remainder of legs mostly brownish or tawny yellow, tarsi somewhat darker. Extreme latero-posterior area of propodeum yellowish, remainder black; abdominal pattern as described for *tsugae* but much lighter, especially at side of third tergum; posterior transverse band just behind yellow marking on terga IV to VII inclusive, and sterna, light brown; ovipositor sheath black. Wing as in *tsugae* except stigma (of type) slightly less angulate on lower margin (Fig. 19, left).

Male—Length, 1.9 mm.; abdomen, 0.8 mm. Color like that of female but more extensively yellow; pronotum entirely yellow except small semicircular black spot on anterior dorsal margin; mesopraescutum black except posterior half traversed by rather dull yellowish brown narrowly projecting anteriorad along parapsidal furrow; dorsal half of mesoscutum dark brown or brownish black, ventral half yellow; rest of thorax colored as in female except inconspicuous yellow present on extreme outer surface in addition to pronounced yellow along inner margin; scutellum brownish yellow with median longitudinal area and rather broad band along transverse line, black; coxae and legs lighter than those of female. Abdominal terga III and IV mostly brown above, brownish or tawny yellow at side; terga V to VII inclusive each with posterior amber band; remainder of abdomen yellow. Proximal 2/3 of submarginal vein with about 10 conspicuous bristles; stigma more nearly oval (Fig. 19, right).

Types.—Holotype, female, Vancouver, B. C., Mar. 24, 1938, W. Mathers (*Tsuga heterophylla* seed, 17595 lot 7, WM 84); allotype, and two male paratypes with same data. Holotype, allotype, and one paratype in the Canadian National Collection, Ottawa. One paratype in the collection of the University of Minnesota.

Type Locality.—Vancouver, British Columbia, Canada.

Host.—Seeds of *Tsuga heterophylla* (Ref.) Sarg.

Variations—Very little variation is noted among the few males at hand. The mesopraescutum may be entirely black and the anterior half of the scutellum almost entirely yellowish brown. A faint brown spot may also appear on the extreme latero-posterior corner of the pronotal dorsum as in the female.

Four females showing the following deviations from the typical female have been assigned to this variety. They are larger, having the following dimensions: Length, 2.5 mm.; abdomen, 1.2 mm.; ovipositor sheath, 1.8 mm. They have rather sharp, conspicuous transverse rugae on the dorsum of the pronotum, and the stigma has the rectangular shape as in typical *tsugae*. The carination of the propodeum differs to the extent that, in addition to the

presence of a distinct or an indistinct median carina, there are weakly arched or nearly regular longitudinal lateral carinae; whereas, on the type the area laterad of the median carina is sculptured with very weak reticulate carinae. The black thoracic pattern as given in the description is mostly dark brown on these larger specimens (presumably due to killing before the color had intensified), and the yellow markings are overcast with brown on the dorsum of the mesothorax. The mesopleurum may be invaded by light brown especially along the depression, but even with the trend toward a darker appearance there is no indication of an infuscation on the hind femur as in typical *tsugae*. These specimens, which are in the collection of the U. S. National Museum, were taken in quarantine at Washington and are labeled as having been reared from seeds of *Tsuga heterophylla* from Ottawa, Canada.

Distribution.—Canada (British Columbia, Ontario).

Comments—Further study of additional material may indicate that this variety, as described, should be regarded as a good species or subspecies, and that the larger specimens referred to under "variations" are in reality a variety of *tsugae*. The difference in shape of the stigma and the presence of a more definite median carina, as well as slight differences having to do with body sculpture, appear obvious on the type specimens. But these features are subject to some variation and are therefore of only limited value for specific differentiation in many instances. The absence of black on the hind femur, as well as other obvious differences in coloration of the thorax and abdomen, will at once separate this variety from typical *tsugae*.

MEGASTIGMUS HOFFMEYERI Walley

Fig. 21

Megastigmus spermotrophus var. *canadensis* Hoffmeyer, Ent. Meddel., vol. 17, p. 218, 1930: Laidlaw, Scot. For. Jour., vol. 45, pp. 187, 190, 1931: Escherich, Zeit. f. angew. Ent., vol. 25, pp. 366, 374, 1938.

Megastigmus spermotrophus var. *hoffmeyeri* Walley, Can. Ent., vol. 64, p. 188, 1932 (New name for *canadensis*, preoccupied by *M. canadensis* Ashm., 1887).

Megastigmus spermotrophus Wachtl, Walley, Can. Ent., vol. 64, p. 189, 1932.

Female—Length, 2.1 mm.; abdomen, 0.9 mm. Ovipositor sheath, 1.5 mm. Head from above transverse oval; vertex higher behind ocellar area, finely transversely rugulose; ocelloccipital line slightly more than ½ ocellocular line or a little less than ½ posterior ocellar line; occipital carina somewhat angulate medially above, nearly attaining top of vertex; antennal scrobe very shallow; scape equal in length to pedicel, ring segment, FI and about ½ FII; pedicel wider and a little longer than FI which is slightly narrower than remaining segments; funicular segments of nearly equal length, each less than twice as long as wide. Pronotum distinctly wider than long, finely transversely rugulose above, flange on anterior dorsal margin weakly emarginate; mesopraescutum with typical sculpture; mesoscutum, axilla and scutellum to transverse line shingled or irregularly rugulose, scutellum behind transverse line indistinctly reticulate to striate, smoother on posterior border; vestiture on thorax relatively sparse, but rather strong. Propodeum with weak median carina, remaining carinae irregular or reticulate except for lateral arcuate

carina; abdomen (usually) subcompressed, smooth and polished; ovipositor strongly arched at base.

Color brownish yellow or orange. Head brownish yellow except face below and gena lighter yellow, and occiput brown; scape and pedicel yellowish beneath, remainder of antenna brown; ocelli partially surrounded by dark brown patches (which may extend forward or converge toward antennal scrobe). Thorax brownish yellow (usually anterior area of mesopraescutum, mesoscutum, axilla and median area of scutellum slightly darker); legs somewhat lighter. Propodeum with dark brown to black on anterior margin, along median carina, and about spiracle (this dark color often absent); abdomen almost uniformly brownish yellow or amber, slightly darker above; area at base of cercus and ovipositor sheath dark brown to black.

Vestiture on dorsal part of head and few hairs on side of face, dorsum of thorax and abdomen, and that on ovipositor, black; remainder of vestiture largely pale. Stigma (elongate) oval, without surrounding cloud (Fig. 21, left); stigmal vein as long or nearly as long as stigmal width; stigmal sector relatively long; proximal $\frac{2}{3}$ of submarginal vein with 7 to 9 conspicuous bristles.

Male—Length, 1.8 mm.; abdomen, 0.8 mm. Head similar to that of female; ocelloccipital line almost equal to ocellocular line (proportion of 5 to 6) or slightly less than $\frac{1}{2}$ posterior ocellar line; pedicel subequal to FI, otherwise antenna similar to that of female. Thorax narrower; character of sculpture and vestiture much as in female. Median carina of propodeum weak but distinct (often interrupted), remaining carination like that of female; abdomen compressed, almost entirely smooth, polished (except sometimes very delicate aciculations evident on posterior terga), and with sparse vestiture.

Color as in female except most of head, side of pronotum, thoracic pleura and legs lighter, approaching yellow; area about ocelli (often) dark or with irregular brown spots partially surrounding each ocellus; antenna lighter brown. Propodeum orange or brownish yellow at lateral and posterior margin, dark brown to black on anterior margin and on median area; median dorsal area of abdominal terga III and IV, posterior border of V and VI, and much of tergum VII, brown; remainder of abdomen brownish yellow to amber.

Color of vestiture much as in female. Stigma oval (Fig. 21, right); stigmal sector relatively long; proximal $\frac{2}{3}$ of submarginal vein with about 7 conspicuous bristles.

Redescribed from a female, Jamestown, N. Y., Dec. 28, 1934, Bugbee (Emerged from Hemlock cones, May 22, 1935), and a male with the same data. Both specimens are in the collection of the University of Minnesota.

Types.—Probably in Hoffmeyer's collection, Copenhagen, Denmark.

Type Locality.—Canada (Eastern).

Host.—Seeds of *Tsuga canadensis* (L.) Carr. Hoffmeyer (1930) recorded three females he believed to be this species from seeds of *Abies amabilis* from Washington, under the name *M. spermotrophus* var. *canadensis;* this record is here not accepted until confirmed by additional rearings.

Variations—Females vary in size as follows: Length, 1.9 mm. to 3.0 mm.; abdomen, 0.7 mm. to 1.4 mm.; ovipositor sheath, 1.3 mm. to 1.7 mm. The shape of the stigma, propodeal carination and contour of the head above are parts that vary noticeably. The stigma of specimens from Canada is narrower, more elongate and constricted below the junction with the stigmal vein, while that of others, especially those from Albany, N. Y., is more oval and not especially constricted. Carination of the propodeum is very variable; frequently the median carina is stronger, while on other specimens it is very weak or interrupted; lateral arcuate carina also vary from those that are very fine, to coarse, irregular ones. Sometimes the ocellocular line is longer than described and the vertex may not be as convex behind the ocellar area as described. Color is nearly constant except the dark patches around the ocelli and on the occiput; the dark brown or black on the propodeum may be almost totally absent.

Males vary somewhat the same as do females. Some of the specimens from Canada have a slightly more elongate-oval stigma with a constriction as in the females from the same locality. The infuscated or brown longitudinal dorsal stripe on the basal abdominal terga may be as extensive as to include tergum VII which may appear even more extensively brown than the preceding two or three. Lighter males have but little dark color on the propodeum or on the abdomen. Variation in size of males examined is as follows: Length. 1.8 mm. to 2.4 mm.; abdomen, 0.8 mm. to 1.1 mm.

Distribution.—Connecticut, New York, Canada (Ontario, Quebec).

Comments—This species appears to be closely related to *spermotrophus* Wachtl but may be distinguished from it by several apparently significant structural differences: Relatively shorter scape; comparatively shorter basal funicular segment; shorter ovipositor; smaller size; and fewer strong bristles on the anterior ⅔ of the submarginal vein. Females of this species also bear a close resemblance to light *americanus* females from which they can be separated by the longer ovipositor, difference in shape of the stigma (*Cf.* figs. 10 and 21), as well as by other differences noted in the descriptions and keys. The position of this species, like that of *tsugae*, in any phylogenetic scheme of the species is somewhat uncertain.

Hoffmeyer (1930) described this as a variety of *spermotrophus* under the name *canadensis*. He supposedly reared specimens from two hosts, namely, *Tsuga canadensis* and *Abies amabilis*. In all probability two species were involved; the one reared from *T. canadensis* is here known as *hoffmeyeri*.

MEGASTIGMUS SPERMOTROPHUS Wachtl

Fig. 31

Megastigmus spermotrophus Wachtl, Wien. ent. Ztg., vol. 12, p. 24, 1893; Centralbl. f. d. ges. Forstw., vol. 19, p. 8, 1893: MacDougall, Trans. Roy. Arbor. Soc., vol. 19, Pt. 1, pp. 52-65, 1906; Jour. Bd. Agr., Lond., vol. 12, pp. 615-621, 1906: Crosby, Cornell Agr. Exp. Sta. Bul. 265, pp. 368, 379-380, 1909: Morley, Cat. Brit. Chalcid., p. 10, 1910: Rohwer, U.S.D.A. Bur. Ent., Tech. Ser. 20, Pt. 6, pp. 160-162, 1913: Crosby, Ann. Ent. Soc. Amer., vol. 6, p. 163, 1913 (in part): Gahan, Proc. Ent. Soc. Wash., vol. 24, pp. 40, 49, 52, 1922 (in part): Hoffmeyer, Ent. Meddel., vol.

17, p. 217, 1930 (in part); Ent. Meddel., vol. 17, pp. 265 (in part), 267, 1931: Laidlaw, Scot. For. Jour., vol. 45, pp. 177-178, 184-190, 1931: Vayssiere, Rev. path. veg. de'nt. agric., vol. 18, p. 181 et seq. (p. 186, in part): Oudemans, Ent. Ber., vol. 8, p. 466, 1933: Escherich, Zeit. f. angew. Ent., vol. 25, pp. 366, 377-378, 1938 (in part).

Megastigmus sp. B. Riley, Proc. Ent. Soc. Wash., vol. 2, p. 360, 1893 (in part).

Megastismus spermatotrophus Dalla Torre, Cat. Hymen., vol. 5, p. 287, 1898 (emendation): Rodzianko, Bul. Soc. Imp. Nat. Moscou, vol. 21, p. 600, 1908: Schmiedeknecht, Gen. Insect., fasc. 97, p. 119, 1909.

Megastigmus pinus Parf., Ashmead, Mem. Carn. Mus., vol. 1, No. 4, p. 244, 1904 (in part).

Female—Length, 3.7 mm.; abdomen, 1.4 mm. Ovipositor sheath, 3.2 mm. Head from above transverse oval, between 1½ and nearly 2 times as wide as long; length of malar space greater than ½ height of compound eye; occipital carina arcuate to weakly angulate dorsally and dorso-laterally; ocelloccipital line slightly more than ½ of either ocellocular line or posterior ocellar line; eye oval and bulging; transverse rugulae on vertex weakly extended on temple and merge anteriorly with arcuate rugulae from front; antennal scrobe somewhat shallow, scarcely attaining anterior ocellus, not (usually) defined dorsally by strong carina; scape equal in length to pedicel, ring segment FI and little more than ½ FII; pedicel shorter but wider than FI, latter subcylindrical and only about twice as long as wide but longer and narrower than FII; remaining funicular segments of about equal width and each less than twice as long as wide. Pronotum distinctly wider than long with weak median emargiantion on anterior flange, and dorsum with transverse rugae; vestiture (usually) sparse or absent on median area of pronotal disc; mesopraescutum anteriorly with fine rugulae, posteriorly with coarser and more transverse rugae which continue onto mesoscutum; scutellum anterior to transverse line finely and irregularly rugulose appearing somewhat shingled from certain angles; area behind transverse line mostly smooth except shallow punctations anteriorly; axilla obliquely rugulose; hind tarsus approximately ⅔ length of tibia; dorsal measurement of first hind tarsal segment equal to, or only slightly longer than entire length of second segment (or dorsal measurement of first hind tarsal segment distinctly less than twice dorsal measurement of second tarsal segment); body vestiture of moderate length and mostly arising from conspicuous black bases on dorsum; scutellar hairs more or less restricted to two lateral regular or irregular rows. Propodeum with median area elevated, distinctly longitudinally carinate with more or less weak but definite median carina more pronounced anteriorly (usually), and stronger arcuate carinae latero-posteriorly; groove below propodeal spiracle shallow and defined posteriorly by sharp carina; abdomen compressed (or sometimes subcompressed), smooth, polished; ovipositor upcurved, normally strongly arched at base.

Color brownish yellow or orange (testaceous). Head brownish yellow; faint triangular infuscation at side of clypeus and circular spot on gena scarcely perceptible; ocelli partly or completely surrounded by dark brown patches; antenna brown except scape almost entirely, pedicel beneath and ring segment, brownish yellow. Pronotum mostly uniform brownish yellow except lighter yellow on posterior margin; remainder of thorax entirely brownish yellow

except somewhat more intensified (approaching amber or reddish brown) on anterior area of mesopraescutum, outer dorsal areas of both mesoscutum and axilla, median area of scutellum, and propodeum especially; legs for most part concolorous with thoracic pleura. Abdomen entirely deep amber and brownish yellow; brown patch present on median basal area of tergum III, and small, dark brown or black spot at base of cercus; ovipositor black.

Vestiture of vertex, dorsal and lateral areas of front, gena, dorsum of thorax, abdomen, front femur and row on front and hind tibiae, dark; remainder largely pale. Proximal ⅔ of submarginal vein with 11 to 16 conspicuous bristles; stigmal vein as long as or longer than width of stigma, latter elongate-oval and without surrounding infuscation (Fig. 31, left).

Male—Length, 3.0 mm.; abdomen, 1.2 mm. Shape and dimensions of head much same as given for female; length of malar space at least ½ height of compound eye; ocelloccipital line at least ⅔ as long as ocellocular line; eye oval and bulging; gena mostly smooth; scape equal to combined lengths of pedicel, ring segment, FI and ½ FII; pedicel nearly as wide as FI and about ⅔ as long; funicular segments each longer than wide, FII being subequal to FI. Sculpture, vestiture of thorax, and measurements of hind tarsal segments very similar to those of female. Propodeum (often appearing coarsely reticulate) with distinct, complete median carina as well as (usually) two or three short carinae extending from anterior margin on each side; arcuate lateral carina irregular and (frequently) less distinct; abdomen much compressed; tergum III (apparent first) smooth and polished, remaining terga very finely aciculate.

Color mostly lemon yellow. Head lemon yellow; ocelli (sometimes) partially surrounded by irregular dark brown to black patches (which often coalesce, connecting ocelli); antenna light brown except scape for most part, and pedicel beneath, brownish yellow. Thorax lemon yellow except anterior dorsal area of mesoscutum orange yellow (often extreme anterior margin black); legs mostly tawny yellow. Propodeum yellow except infuscated with brown especially adjacent to anterior and median posterior margins and along median carina; abdomen pale brownish yellow with brown on terga III and IV medially above, and each of median segments with very pale amber posterior border (abdomen sometimes with narrow, longitudinal brown stripe on dorsum, or first two or three terga almost entirely brown over median dorsal area).

Proximal ⅔ of submarginal vein with 10 to 13 conspicuous bristles (usually 12 to 13); stigma shorter and more oval than that of female (Fig. 31, right).

Redescribed from a female, Targhee National Forest, Idaho, (About 6,000 feet), 1939, J. W. Augenstein (Ex seed of *Pseudotsuga taxifolia*, St. Paul, Minn., Jan. 24-27, 1940); and a male, with same data except reared Dec. 16, 1939. Specimens in the collection of the University of Minnesota.

Type.—Probably in Vienna, Austria.

Type Locality.—Western United States and southwestern Canada (Vancouver Island).

Host.—Seeds of *Pseudotsuga taxifolia* (Lam.) Britt.

Variations—Length of the female is from 2.8 mm. to 4.3 mm.; abdomen,

1.1 mm. to 2.1 mm.; ovipositor sheath, 2.5 mm. to 4.6 mm. The carination of the propodeum is variable, with some specimens having an indistinct median carina. The shape of the stigma is not constant but in most cases, however, it can be recognized as conforming to that figured. Coloration is comparatively stable, there being relatively few specimens appearing lighter than described. Specimens once preserved in fluid are generally lighter (more yellowish) when placed on card points.

Males are much more variable in coloration than are females. Frequently the ocellar area, the anterior margin of the pronotum, the extreme outer area of the axilla, the lateral area of the metanotum, the propodeum, and at least the basal abdominal terga may appear dark brown to black. Darker males of this species may be confused easily with those of *rafni* Hoffm., particularly when dark brown or black appears on the axilla; however, in such cases the dark coloration is never extensive on the axilla, being restricted to the extreme outer surface or being apparent as an indefinite light brown infuscation on the anterior margin. Males vary in size as follows: Length, 2.7 mm. to 3.7 mm.; abdomen, 1.0 mm. to 1.9 mm.

Distribution.—California, Colorado, Idaho, New Mexico, Oregon, Washington. Also recorded from Canada (Vancouver Island). Specimens have been examined that were reared from Douglas fir seeds in Scotland (Aberdeenshire) and New Zealand (Tapanui) where the species was undoubtedly introduced, as it has been in Germany and other countries of Western Europe.

Comments—Females of this species may be distinguished from all others (except from some females of *rafni* Hoffm., q.v.) by size, elongate-oval stigma, relatively long stigmal vein, and almost uniform brownish yellow or orange body color. Typical males may be distinguished by the almost entirely lemon yellow body color. See also comments under *rafni*.

Megastigmus spermotrophus var. **nigrodorsatus** n. var.

Fig. 30

Male—Length, 3.8 mm.; abdomen, 1.9 mm. Structurally similar to male of typical spermotrophus except for larger size, sharper sculpture and stronger vestiture.

Color black and lemon yellow. Head yellow except vertex with large, somewhat quadrilateral black spot extending from occipital carina to within antennal scrobe above, leaving narrow yellow stripe above eye; occiput mostly black; antenna brown. Dorsum of pronotum with large median black spot which is wider anteriorly, becoming very narrow at posterior margin; remainder of pronotum lemon yellow; mesopraescutum entirely black except narrow stripe bordering parapsidal furrow; mesoscutum with rather broad oblique spot on median dorsal surface, remainder yellow; approximate outer half of axilla black, inner margin yellow; scutellum yellow above except black along transverse line and with complete, median longitudinal black line; metanotum mostly black at side, and its median piece yellow; remainder of thorax yellow. Propodeum black except yellow spot on latero-posterior border; abdomen yellow except terga III to VII and most of VIII black above, and basal sternum yellow to brown.

Vestiture stiff, black. Wing as described for typical *spermotrophus* except proximal ⅔ of submarginal vein with about 15 conspicuous bristles, and stigma somewhat more oval in shape (Fig. 30).

Female—Length, 5.3 mm.; abdomen, 2.3 mm. Ovipositor sheath, 4.6 mm. Color mostly deep orange yellow (or yellowish brown). Face light brownish yellow infuscated with brown above clypeus, on cheek and on lower genal area; remainder of head orange yellow except darker above especially on ocellar area; each ocellus surrounded by dark brown or black which is only faintly continuous between ocelli; occipital foramen bordered by narrow dark brown area. Dorsum of pronotum light orange yellow anteriorly gradually shading to light yellow at side and posteriorly; remainder of thorax and propodeum mostly deep orange or rufescent amber, shading to light orange yellow or yellow along parapsidal furrow and at side of scutellum; anterior margin of mesopraescutum brown; median piece of metanotum lemon yellow; legs light brownish yellow, middle and hind coxae somewhat darker. Abdomen orange yellow except small brown spot at base of tergum III above, and small, narrow black spot at base of cercus; ovipositor dark brown to black.

Wing as in typical *spermotrophus* except stigma slightly bent mesad, and proximal ⅔ of submarginal vein with about 17 conspicuous bristles.

Types.—Holotype, male, Figueroa Mt., Calif., Oct. 27, 1937, J. E. Patterson (Ex seed, *Pseudotsuga macrocarpa,* 31974A Hopk. U. S.); allotype, with same data as holotype. Holotype and allotype are in the collection of the U. S. National Museum. Paratypes: 3 males, San Bernardino, Calif., April, 1931, C. J. Kraebel (*Pseudotsuga macrocarpa,* 18376a Hopk. U. S.). Two paratypes deposited in the collection of the U. S. National Museum, and one in the collection of the University of Minnesota.

Type Locality.—Figueroa Mountain, California.

Host.—Seeds of *Pseudotsuga macrocarpa* (Torr.) Mayr.

Variations—The males examined are surprisingly uniform in coloration. A few have the black extended along the occipital carina onto the temple. A small black spot may appear on the lower anterior margin, and another at the extreme median dorsal area of the side of the pronotum.

Few females are at hand and consequently a discussion at this time can hardly encompass even the average range of variation that may occur.. There is an obvious range of variation in color of the females which were available for study. A single specimen, which is evidently discolored because of once having been preserved in fluid, appears drab brown instead of the color given in the description. The natural coloration of this specimen may have been darker, since the infuscation on the face and gena, and the color of ocellar area, as well as that of the occiput are more intense. The pronotum may be brown at the median dorsal anterior margin, and a minute brown spot may appear on the lower anterior margin of the side. In addition, the anterior margin of the mesopraescutum may be black and the approximate outer half of the axilla light brown. Sometimes there may be an intensified brownish spot at the base of the fourth abdominal tergum.

In addition to the type material nine males and three females have been examined.

Distribution.—California.

Comments—This variety can be distinguished at once by the black coloration on the dorsum of the male, to which the name *nigrodorsatus* applies. The female closely resembles the larger, more robust specimens of typical *spermotrophus*, but these may be separated by noting a slight difference in color, as well as the difference in sharpness of sculpture. The female of *nigrodorsatus* has at least the posterior half of the pronotum for the most part yellow which contrasts sharply with the dark orange or yellowish brown mesonotum, and especially with the dark brown or black anterior margin of the mesopraescutum; while in typical *spermotrophus* the pronotum is more nearly concolorous with most of the mesonotum. In addition, the females of this variety have strong vestiture and at least sometimes much sharper sculpture.

The larger size, sharper rugose sculpture and stronger vestiture, as well as the slight difference in shape of the stigma in the male may be merely variations that are associated with the different species of host. If future study should demonstrate that natural host specificity is involved in producing this form, perhaps it would be more desirable to regard it as a subspecies rather than as a variety.

MEGASTIGMUS PINUS Parfitt

Fig. 29

Megastigmus pinus Parfitt, Zool., vol. 15, pp. 5543, 5629-5630, 1857 (♀ only); Cresson, Trans. Amer. Ent. Soc., suppl. vol., p. 236, 1887: Riley, Proc. Ent. Soc. Wash., vol. 2, p. 360, 1893: Dalla Torre, Cat. Hymen., vol. 5, p. 287, 1898 (in part): Ashmead, Mem. Carn. Mus., vol. 1, No. 4, p. 244, 1904 (in part): Rodzianko, Bul. Soc. Imp. Nat. Moscou, vol. 21, p. 600, 1908: Schmiedeknecht, Gen. Insect., fasc. 97, p. 119, 1909: Crosby, Cornell Agr. Exp. Sta. Bul. 265, p. 368, 1909: Rohwer, U.S.D.A. Bur. Ent., Tech. Ser. 20, Pt. 6, p. 160, 1913: Crosby, Ann. Ent. Soc. Amer., vol. 6, p. 160, 1913 (♂ & ♀): Gahan, Proc. Ent. Soc. Wash., vol. 34, pp. 40, 49, 1922: Hoffmeyer, Ent. Meddel., vol. 17, p. 215, 1930: Laidlaw, Scot. For. Jour., vol. 45, pp. 178-179 et seq., 1931: Oudemans, Ent. Ber., vol. 8, pp. 467-469, 1933: Escherich, Zeit. f. angew. Ent., vol. 25, pp. 366 et seq., 1938.

Megastigmus sp. A. Riley, Proc. Ent. Soc. Wash., vol. 2, p. 360, 1893 (in part).

Megastigmus pinus var. *crosbyi* Hoffmeyer, Ent. Meddel., vol. 17, p. 215, 1930 (♀ only): Laidlaw, Scot. For. Jour., vol. 45, pp. 188, 190, 1931: Escherich, Zeit. f. angew. Ent., vol. 25, pp. 366, 367, 371, 1938.

Female—Length, 5.1 mm.; abdomen, 2.6 mm. Ovipositor sheath, 5.6 mm. Head from above transverse oval, slightly more than 1½ times as wide as long; vertex with rather large, shallow, setigerous punctures and distinct rugae which extend onto lateral frontal areas; occipital carina sharp, angulately rounded dorso-medially and dorso-laterally; ocelloccipital line greater than lateral ocellar line or between ½ and ⅔ as long as either ocellocular line or posterior ocellar line; gena smooth, polished; antennal scrobe deep, distinctly defined at side, not attaining anterior ocellus; scape little longer than combined lengths of pedicel, ring segment and FI; pedicel oval, subequal to FI; FI twice as long as wide, slightly longer than FII; remaining funicular segments of nearly equal width and each twice as long as wide. Pronotum wider than long from dorsal aspect, its dorsum coarsely and irregularly rugose with large shallow pits, and flange on anterior dorsal margin with rather shallow emar-

ginations; mesopraescutum with irregular, arched rugulae on anterior 1/3, becoming more transversely sculptured behind; mesoscutum finely rugulose on inner angle, more coarsely sculptured and pitted toward outer margin; axilla obliquely rugulose; scutellum with irregular transverse rugulae anterior to transverse line, with longitudinal rugulae. Propodeum distinctly elevated, anteriorly with coarse, irregular reticulate sculpture, and somewhat arcuate carinae on posterior half; median carina weak; spiracular groove deep, sharply defined especially mesially; abdomen compressed, polished, with fine and almost imperceptible transverse aciculations; ovipositor upturned, more strongly arched at base.

Color jet black, yellow and orange. Face yellow except angulate black patch at side of clypeus extending from fronto-genal suture to antennal base; yellow surrounding eye broadly interrupted with black on inner dorsal margin, more narrowly so on temple and on either side of fronto-genal suture; remainder of head black; antenna dark brown or black except scape yellow beneath, and pedicel and ring segment partly brownish yellow beneath. Pronotum black, its side and trilobed transverse band on posterior dorsal margin greenish yellow; mesothorax black except spot on outer margin of mesoscutum (may be absent), small circular spot on mesopleurum below wing base, and tegula yellow, and posterior half of mesopraescutum, inner angles of both mesoscutum and axilla, and scutellum forming oblong reddish orange spot; front coxa basally, middle coxa basally and on outer surface, and hind coxa entirely, black, remainder of coxae yellow; front and middle femora yellow except latter infuscated basally; proximal 4/5 of anterior and ventral surfaces of hind femur (often) black, remainder yellow; tibiae and tarsi mostly brownish yellow. Propodeum black; abdominal tergum III (apparent first) entirely black; anterior dorsal ⅔ of tergum IV black except transverse yellowish spot laterad of median dorsal line (on some almost obscure, on others united with lateral spot), and another yellow spot at side, with posterior 1/3 of tergum bordered by transparent brown (because of successive overlapping, yellow on dorsum appears brownish yellow when covered by posterior margin of preceding segment); pattern of following four terga essentially like that of IV but yellow lateral spots become successively larger and those above elongate mesoobliquely and converge so that tergum VIII, which is predominantly yellow, has lateral black areas reduced to spiracular region; tergum IX black with narrow brownish yellow stripe on posterior margin; sterna dark brown to black; ovipositor black.

Vestiture relatively long and conspicuous, rather evenly distributed on anterior ⅔ of scutellum, that on thorax, legs, and face pale; remainder of vestiture mostly dark. Stigma oval (Fig. 29, left) and without distinct surrounding infuscation; proximal ⅔ of submarginal vein with 17 or 18 conspicuous bristles.

Male—Length, 4.4 mm.; abdomen, 2.8 mm. Head similar to that of female; occipital carina slightly angulate above; ocelloccipital line about equal to lateral ocellar line, or ½ ocellocular line, or less than ½ posterior ocellar line; gena mostly smooth; scape thicker than that of female and about equal to combined length of pedicel, ring segment and FI; pedicel ovate and as

wide or wider than FI, and about ⅔ as long; FI and FII equal in width but subequal in length, each a little less than twice as long as wide; remaining funicular segments successively decrease only slightly in length. Pronotum feebly emarginate on anterior flange, irregularly and coarsely transverse rugose with large shallow punctures or depressions; mesopraescutum, mesoscutum, axilla and anterior ⅔ of scutellum sculptured as in female, though less distinctly punctate; area behind transverse line coarsely and obliquely rugose, somewhat punctate medially. Propodeum elevated and defined posteriorly as in female; median carina especially evident anteriorly but not markedly stronger than several antero-lateral carinae; abdominal terga III (apparent first), IV, VIII and IX smooth; terga V to VII minutely aciculate on anterior ⅔, each with polished posterior margin.

Color jet black and yellow. Head above black with yellow spot above eye, tawny yellow below; scape yellow beneath, black above; remainder of antenna dark brown to nearly black. Pronotum black except side and two irregularly shaped spots on latero-posterior margin of dorsum, greenish yellow; remainder of thorax black except lower part of propleurum, tegula, and spot under base of front wing, greenish yellow; front coxa yellow; middle coxa brownish yellow; hind coxa black; all femora yellow except hind femur with longitudinal stripe on proximal ⅔ of anterior surface; tibiae and tarsi tawny yellow. Abdominal tergum III black; tergum IV black above and dark brown at side except for greenish yellow circular spot; terga V to VII black above, with anterior ⅔ of side greenish yellow bordered behind with pale brown (amber) margin which overlaps basal area of succeeding tergum; remaining terga orange yellow except distal end of tergum IX which is black; basal sterna dark brown to black, part of fourth sternum and those beyond yellow.

Vestiture on dorsum of head, front and cheeks, some on antenna and dorsum of abdomen, black; that on remainder of body pale. Stigma oval (Fig. 29, right), without distinct infuscation; proximal ⅔ of submarginal vein with about 14 strong bristles.

Redescribed from a female, General Grant National Forest, Calif., Oct. 28, 1916, J. M. Miller (Reared, *Abies magnifica* var. *shastensis*, 12578c Hopk. U.S.); and a male, Mineral King, Calif., Oct. 28, 1916, F. P. Keen (Reared, *A. magnifica* var. *shastensis*, 13296g Hopk. U.S.). Both specimens are in the collection of the University of Minnesota.

Type.—Female, in the collection of the British Museum (N.H.), London.

Type Locality.—California.

Hosts.—Seeds of *Abies* spp. The following host species are reported in this study: *A. amabilis* (Doug.) Forbes, *A. concolor* Lindl. & Gord., *A. grandis* Lindl., *A. lasiocarpa* (Hook.) Nutt., *A. magnifica* Murr., *A. magnifica* var. *shastensis* Lemm., and *A. nobilis* Lindl.

The literature relating to this species contains some very doubtful, and certainly some erroneous host records. Parfitt (1857a) described the female of *pinus* from specimens "found amongst the seeds of *Picea bracteata* and a new species of *Tryja*, and in *Pinus nobilis*, etc." Parfitt's "*Picea bracteata*" may have been the same as *Abies venusta*, but as yet we appear to have no authentic rearings of *pinus* from that host or from *Thuja* sp. It is doubtful if any of the records in the literature of these two hosts are based on material reared subsequently to the time of Parfitt's paper. Rohwer (1913) added "*Tsuga* sp." in referring to Parfitt's original paper; this error has been copied by several. Von

Tubeuf (1930b) recorded *M. pinus* from *Pinus sylvestris* L., a very doubtful record as is also Hoffmeyer's (1931) record of the species from *Picea sitchensis*.

Variations—From the standpoint of structure and color pattern, this appears to be one of the most variable species of the genus in North America. Specimens reared from the seeds of *A. magnifica* and its variety, *shastensis*, are usually distinctly larger with coarser sculpture and denser, stronger vestiture, aside from the fact that the ovipositor sheath is obviously longer than the body length. In most respects, individuals from the seeds of *A. nobilis* are intermediate between the above and those from *A. concolor* except for variations in color. The ovipositor sheath of specimens from *A. concolor* in about equal to the body length or slightly longer. On the other hand, specimens procured from the seeds of *A. lasiocarpa* and *A. grandis* are smaller, more weakly sculptured, have the ovipositor sheath slightly shorter than the body length, and have a more extensive lighter color pattern. The following are some of the more important variations that may be encountered in *pinus*.

Female. Structural variations between these forms involving parts of the head and basal funicular segments may be noted. The height of the compound eye and the length of the malar space are variable within certain limits. Sometimes the occipital carina is evenly arched above instead of being angulately rounded. The stigmal vein may be noticeably widened before entering the stigma proper; and the stigma itself is subject to considerable variation in shape. The number of bristles on the proximal ⅔ of the submarginal vein, although usually between 14 and 16, is by no means constant. The vestiture on the scutellum (which in this species is not restricted to a single lateral row) of larger, coarser specimens is more evenly distributed, whereas on others it may be largely restricted to the lateral areas.

Individual specimens from *A. grandis*, *A. lasiocarpa*, and many from *A. concolor*, and a very few from *A. magnifica* var. *shastensis* have the head more extensively yellow, with a narrow, angulate yellow line extending from above the compound eye to a point behind the ocelli (frequently the two extensions are united); the black facial markings of such specimens are materially reduced or absent. These may also show a predominance of yellow on the pronotum and have the black pattern reduced to a narrow anterior margin and an oblique latero-dorsal line. The typical orange pattern on the dorsum of the mesothorax may become in part or entirely yellowish, and yellow may appear in limited extent on the mesosternum, mesepimeron, and metepisternum. In addition, such specimens usually do not exhibit any black on the outer surface of the hind femur. All gradations occur from this extreme variation to the typical form. The abdominal pattern appears to be comparatively constant, except that some of the extreme variants may have the dorsal area of tergum IV entirely black, and individuals from *A. nobilis* usually have the transverse, latero-dorsal yellow spots broadly united with the lateral yellow areas especially on terga IV and V (the dorsal and lateral yellow areas on other forms are usually interrupted with black). Sometimes the dorsal transverse spots on the pronotum may be narrowly and completely divided. Dark variants, involving the orange or yellow dorsal pattern on

the mesothorax, also occur; there may be a dark circular spot on the anterior half of the scutellum, and much of the area behind the transverse line may be nearly black. The replacement of the bright orange mesothoracic pattern by very dark brown was observed in series of specimens reared from both *A. concolor* and *A. magnifica* var. *shastensis*.

Females vary in size as follows: Length, 2.8 mm. to 5.5 mm.; abdomen, 1.4 mm. to 2.8 mm.; ovipositor sheath, 2.3 mm. to 6.7 mm.

Male. Males are less variable than females. The scutellum behind the transverse line is sometimes mostly punctate. The shape of the stigma is variable to the extent that specimens reared from *A. nobilis, A. concolor* and *A. grandis* usually have a more circular stigma and not the oval type more commonly encountered in material reared from *A. magnifica*; the oval stigma closely resembles that of the following species. Frequently the stigma may be very narrowly surrounded by a noticeable amount of infuscation. The dorsal yellow spots on the pronotum in particular, and areas of the same color on the mesoscutum may be either present or absent. Lighter colored males corresponding to similar colored females have the outer area of the mesoscutum, the mesopleurum in part or almost entirely, the prepectus, the hind coxa distally, and the sides of the abdominal segments except the first, lemon yellow. The yellow band around the eye is often only narrowly interrupted latero-dorsally on the frontal area. In rare instances, lighter colored males exhibit a pattern on the dorsum of the mesothorax closely resembling that of a female (1 male, Ashland, Ore., Oct. 9, 1916, F. P. Keen, ex *A. concolor*, 12560T[3] Hopk. U. S.). A number of males have been examined which have black at the side of the penultimate abdominal tergum; others have the median piece of the metanotum entirely yellow, as well as areas of the same color on the anterior part of the scutellum.

Length of males examined varies from 2.6 mm. to 4.5 mm., and the abdomen from 1.1 mm. to 1.9 mm.

Distribution.—California, Colorado, Idaho, Oregon, Washington. Apparently this species has become established in Scotland where it has been reared from the seeds of *A. nobilis* (Laidlaw, 1931).

Comments—According to the original description of the variety *crosbyi* Hoffmeyer (1930), the yellow ring around the eye is broader, and an irregular [yellow] band extends from the eyes to the area behind the ocelli, where it is narrowly interrupted; the yellow on the prothorax is very extensive leaving only an irregular black margin in front and at the side; the hind femur is without a brown stripe on the external surface. Hoffmeyer apparently based his description on specimens approaching the extreme light variation. After a study of a rather large series of *pinus* from seeds of *A. concolor, A. lasiocarpa* and *A. grandis,* hosts in which this variation seems to occur most frequently, a perfect graduation was found to exist especially among those reared from *A. concolor*. The hind femur becomes progressively more infuscated with the gradation toward the typical form. Knowing the extreme variation, and that it is virtually impossible to draw any line of demarkation, the recognition of a variety for the form in question would seem to have little significance.

In spite of the wide range of variation exhibited by this species, no constant character, or combination of characters has been found in the present study that justifies the recognition of subspecific categories without first seriously considering the biological aspects. Though rather large, the series of specimens studied does not permit absolute deductions as to whether there are particular forms which entirely restrict themselves to given host species. Since populations of this species can be segregated into rather well defined groups according to different hosts, it is most probable that the variable characteristics of *pinus* is due largely to the influence of these hosts.

The closest ally of *pinus* is *milleri*, n. sp. described beyond. *Lasiocarpae* Cy. is also closely related. From the former, *pinus* may be distinguished by its pale vestiture on the thoracic dorsum, usually in both sexes, and by the black transverse marking on the abdominal segments of the female usually being constricted medially and not transverse rectangular. From *lasiocarpae*, this species is readily differentiated by the conspicuous orange (or yellow) pattern on the dorsum of the mesothorax of the female. Males of *pinus* may be distinguished from males of the above by the characters given in the key.

Megastigmus milleri n. sp.

Fig. 26

Megastigmus sp. A. Riley, Proc. Ent. Soc. Wash., vol. 2, p. 360, 1893 (in part).

Megastigmus pinus Parf., Crosby, Ann. Ent. Soc. Amer., vol. 6, pp. 162, 168, 1913 (in part).

Megastigmus milleri Rohw., Craighead & Middleton, U.S.D.A. Misc. Pub. 74, p. 16, 1930 (MS name).

Female—Length, 4.2 mm.; abdomen, 1.9 mm. Ovipositor sheath, 3.8 mm. Head transverse oval from above, about 1½ times as wide as long; vertex rugulose-punctate, ocellar region weakly elevated; occipital carina evenly arcuate and extending rather high on vertex; ocelloccipital line about 1/3 posterior ocellar line, or ½ ocellocular line, or ⅔ lateral ocellar line; gena smooth; scape little shorter than combined lengths of pedicel, ring segment and FI; pedicel broadly oval, distinctly shorter than FI which is slightly longer than FII and about twice as long as wide; FII and succeeding funicular segments of equal width and each less than twice as long as wide. Pronotum from above wider than long and somewhat rectangular, with feebly rugulose side weakly convex in outline, flange on anterior dorsal margin rather deeply emarginate medially; pronotal dorsum weakly and irregularly rugulose-punctate or minutely wrinkled and with shallow pits; mesopraescutum and mesoscutum with irregular, fine, transverse rugulae; parapsidal furrow relatively deep, interrupted by numerous rugae; axilla obliquely rugulose; scutellum finely reticulate, acutely rounded anteriorly, its anterior margin ½ or less as wide as hind margin of mesopraescutum, and its side arcuate; transverse line somewhat indefinite (sometimes an anterior median longitudinal groove is very conspicuous); median piece of metanotum more or less crescent-shaped. Propodeum elevated, with sharp, very irregular carination; sharp median carina present (on some received between, or branching into two strong, short carinae pos-

teriorly, and sometimes lateral arcuate or circular carinae may be present at side of median carina); groove below propodeal spiracle (usually) without sharply defined sides; abdomen subcompressed (frequently compressed), polished, with almost imperceptible aciculations; body vestiture of medium length, fine and more or less recumbent on pronotum.

Color greenish to golden yellow and jet black. Head below yellow except circular black spot at side of clypeus; yellow circumorbital band interrupted at inner dorsal margin of eye and on temple; temple posteriorly, and vertex mostly black except extension of yellow behind lateral ocelli; scape, pedicel and ring segment yellow beneath, rest of antenna brown. Pronotum entirely yellow except latero-dorsal black mark with mesal extension in form of wedge at about its middle (sometimes coalescing on disc); mesopraescutum black anteriorly, yellow on posterior half narrowly extending forward along parapsidal furrow; mesoscutum with dorsal black band continuous onto outer half of axilla, remainder of mesoscutum and inner angle of axilla yellow; scutellum entirely yellow except (frequently) anterior median black spot (sometimes extending uninterrupted to posterior margin); spot below front wing base, another on metepimeron, and small spot at posterior ventral margin of metepisternum, yellow; remainder of pleura black; most of metanotum yellow; front coxa yellow, slightly infuscated basally; middle coxa black with yellow on anterior half and distally; hind coxa black with yellow on anterior half and distally; hind coxa black with yellow at extreme distal end; femora yellow except hind femur (frequently) with infuscated stripe on anterior surface; tibiae light brownish yellow; tarsi somewhat darker. Propodeum entirely black; abdominal tergum III (apparent first) black, lighter at side; terga IV to VIII inclusive each with transverse rectangular, black band at base followed by transverse yellow band which is (often) interrupted with black on median dorsal surface of IV; approximate distal 1/3 of terga IV to VII inclusive each with pale amber to brown border; yellow band successively wider and amber band successively paler on more distal terga; last tergum black except trace of yellow beneath; sterna light to dark brown; ovipositor sheath black.

Vestiture on dorsum of head, gena, dorsum of thorax and abdomen, distal ends of front and middle femora, row on outer surface of front and middle tibiae, and that on ovipositor, black; remaining vestiture pale. Proximal $\frac{2}{3}$ of submarginal vein with about 13 conspicuous bristles; stigma (Fig. 26, left) somewhat elongate-oval (or oval), without surrounding infuscation; stigmal vein slightly expanded at junction with stigma.

Male—Length, 3.3 mm.; abdomen, 1.5 mm. Head similar to that of female; scape somewhat medially expanded, slightly shorter than combined lengths of pedicel, ring segment and FI; pedicel ovate, subequal to FI and about as wide as flagellar segments; FI and FII almost equal, remaining segments of funicle about equal in width and each successively shorter. Pronotum somewhat more quadrate, about as long as wide; sculpture of thorax like that of female except less regular, and with more conspicuous setigerous punctures; rugulae on scutellum anterior to transverse line very irregular, somewhat shingled or reticulate; striate-reticulate behind transverse line. Propodeum

with distinct median carina which is branched or weaker posteriorly; carinae irregular laterally; abdominal tergum III smooth, polished, remaining terga mostly finely aciculate at least on anterior ⅔ of each.

Color jet black and yellow. Head black except face, lower area of temple and gena, and (usually) spot above eye, yellow. Pronotum yellow at side, black on dorsum except bilobed, greenish yellow transverse spot on posterior margin (often divided); remainder of thorax black except outer surface of mesoscutum, spot under front wing base, dorsal area of prepectus, and median piece of metanotum, yellow; front coxa yellow; middle coxa yellow with black at base; hind coxa black with yellow at distal end; femora entirely yellow; tibiae and tarsi more tawny to light brown. Abdominal tergum III dark brown to black, remaining terga yellow at extreme side and black above except penultimate tergum which is brownish or orange yellow with black at side, and last tergum orange yellow; basal sterna brown, those beyond tawny yellow.

Vestiture somewhat stronger than that of female but otherwise similar. Proximal ⅔ of submarginal vein with about 12 conspicuous bristles; stigma (Fig. 26, right) more broadly oval (so on allotype, but usually similar to that of female).

Types.—Holotype, female, Crescent City, Calif., (reared) Apr. 26, 1915, J. M. Miller (*Abies grandis*, 12554j Hopk. U.S.); allotype, with same data except Aug. 18, 1914. Holotype and allotype are in the collection of the U. S. National Museum, as type number 19663. Paratypes: 39 females, 16 males, with same data as holotype; 5 males with same data as allotype. Paratypes are in the collections of the U. S. National Museum and the University of Minnesota.

Type Locality.—Crescent City, California.

Hosts.—Seeds of *Abies grandis* Lindl. and *A. magnifica* var. *shastensis* Lemm.

Variations—Female. Relatively few structural variations are noted. The rugosity on some is sharper and more evenly transverse. The carination of the propodeum is very variable as indicated, but usually a sharp carina is present, especially on the anterior half. Although the stigma is close to that of *pinus*, it is usually more elongate and angulately rounded below. Females vary in size as follows: Length, 2.7 mm. to 4.3 mm.; abdomen, 1.3 mm. to 3.7 mm.; ovipositor sheath, 2.6 mm. to 3.8 mm.

On some the yellow circumorbital band may be complete. The extent of black on the pronotum may consist of only two small circular spots on the anterior margin, or the oblique latero-dorsal marking may be rather extensive. Some specimens show larger yellow areas at positions on the pleura than described. Certain specimens may have not only the median longitudinal black line on the scutellum, but considerable black along the transverse line as well. The middle and hind coxae are sometimes entirely black. Yellow may be noted invading the propodeum on either side of the median carina. The pattern on the abdomen appears to be rather constant. A single female from British Columbia, Canada, has a noticeable amount of pale hairs on the scutellum, but otherwise agrees with the description.

Male. There appear to be no striking variations in the male. Some have the yellow circumorbital band nearly complete except for the interruption on the latero-dorsal frontal area. The yellow on the dorsal posterior margin of

the pronotum frequently is divided into two hemispherical spots, and yellow may appear on the pleura, especially on the mesopleurum. The middle coxa may be entirely yellow except for a light basal infuscation, and the hind coxa may have considerable yellow on its distal half. Some specimens possess a very narrow transverse dark band on the distal abdominal terga. Males vary in length from 3.0 to 3.4 mm., and in length of abdomen from 1.3 mm. to 1.6 mm.

Distribution.—California, Canada (Vancouver Island, British Columbia).

Comments—The name *milleri* after Mr. J. M. Miller, senior entomologist, Forest Insect Laboratory, Berkeley, California, was originally a manuscript name of Mr. S. A. Rohwer's choosing, and was fixed to a large series of specimens studied at one time by Mr. Rohwer.

The nearest relative of this species is the form of *pinus* described as the variety *crosbyi* with which it has a very close structural affinity. The narrowed anterior margin of the scutellum, the black vestiture on the thoracic dorsum, the relatively constant, definitely lighter color pattern, and the transverse rectangular, black bands on the abdominal terga in the female have served in all cases to distinguish this species. Males are difficult to separate from those of *pinus*, in all instances. In this species, the anterior margin of the scutellum is more acutely rounded, the vestiture of the thoracic dorsum is black and somewhat shorter, the median piece of the metanotum is entirely yellow, and the side of the penultimate abdominal tergum exhibits some black. It should be noted that the males of *pinus* may also have the sides of the penultimate abdominal tergum black, and the median piece of the metanotum nearly all yellow, but such specimens appear to be relatively uncommon. The separation of *milleri* males from those of other closely related species, *i.e.*, *lasiocarpae* Cy. and *specularis* Wall., is accomplished usually with difficulty (see key) because of the striking resemblance between them.

MEGASTIGMUS LASIOCARPAE Crosby

Fig. 25

Megastigmus lasiocarpae Crosby, Ann. Ent. Soc. Amer., vol. 6, p. 163, 1913: Gahan, Proc. Ent. Soc. Wash., vol. 24, pp. 40, 49, 1922.

Female—Length, 3.7 mm.; abdomen, 1.5 mm. Ovipositor sheath, 3.1 mm. Outline of head from above somewhat hemispherical; vertex evenly convex with rather sharp rugulose sculpture; occipital carina nearly attaining top of vertex; ocelloccipital line equal to ½ ocellocular line, or slightly less than ½ posterior ocellar line; gena smooth; scape equal to combined lengths of pedicel, ring segment, FI and ½ FII, with conspicuous amount of vestiture on inner surface; pedicel distinctly wider and slightly longer than FI which is about twice as long as wide and distinctly longer than FII; remaining funicular segments each but slightly longer than wide. Pronotum wider than long with anterior flange weak and shallowly emarginate, its dorsum with transverse rugae anteriorly, shallow punctures intermixed laterally, and finely rugulose to smooth behind; mesopraescutum finely transversely rugulose; scutellum anterior to transverse line shingled, behind almost smooth. Carination of pro-

podeum sharp and irregular; median carina (often) short, branched, scarcely more prominent than irregular arcuate lateral carina; abdomen smooth, polished; ovipositor weakly arched upward.

Color jet black and yellow. Face except infuscated patch at side of clypeus above mandibular base to gena, stripe behind eye to dorsal region of temple, and spot above eye, yellow; remainder of head black; scape, pedicel and ring segment yellow beneath, otherwise antenna brown. Oval spot on side of pronotum, and tegula mesially, yellow; remainder of thorax black; coxae dark brown to black except approximate distal half of front coxa yellow and middle coxa somewhat lighter brown on anterior surface; hind femur dark brown to black except extreme distal end lighter; rest of legs brown, front leg mostly yellowish brown. Abdomen entirely black except tergum VI and VII each with median lateral yellow spot narrowly projecting toward median dorsal line; ovipositor black.

Vestiture on dorsum of head, scape and pedicel, side of face, thorax and abdomen above, ovipositor, distal end of front femur, row on outer surface of front tibia and posterior surface of hind tibia, black; remaining vestiture mostly pale. Proximal ⅔ of submarginal vein with about 12 conspicuous bristles; stigma oval (Fig. 25, left), without distinct surrounding infuscation.

Male—Length, 2.3 mm.; abdomen, 1.1 mm. (Measurements from a specimen carefully compared with the allotype). Dorsal aspect of head about twice as wide as long; ocelloccipital line greater than ½ ocellocular line, or about ½ posterior ocellar line; scape medially expanded, equal to combined lengths of pedicel, ring segment, FI plus ¼ FII; pedicel oval, wider and slightly longer than FI, about as wide as remaining funicular segments. Pronotum about as wide as long, with fine, irregular transverse rugae on anterior half, behind finely rugulose to smooth; remainder of thorax sculptured as in female. Propodeum with fine, weak, irregular carination; median carina indistinct (or incomplete); abdominal tergum III smooth, polished, remaining ones finely aciculate.

Color jet black and yellow. Pattern very much like that of female except absence of infuscation on face, presence of circular yellow spot beneath front wing base, and only indefinite infuscated stripe on anterior surface of hind femur instead of mostly dark brown or black. Abdominal tergum III entirely black; terga IV to VII inclusive each black above with yellow spot at side bordered posteriorly and ventrally by dark amber band; (tergum VIII anteriorly, and last tergum posteriorly, brown, remainder dark orange; first sternum and base of second, brown, sterna beyond yellow).

Color and character of vestiture as in female. Proximal ⅔ of submarginal vein with 9 to 10 conspicuous bristles; stigma (Fig. 25, right) similar to that of *milleri* male.

Redescribed.—Holotype, female, (Rye, Colorado, Jan. 29, 1909, O. S. Mackelfresh), C. U. Exp. No. 832, June 5, 1909, *Abies lasiocarpa*, Colorado; allotype, with same data. Holotype and allotype are in the collection of Cornell University, under numbers 39.1 and 39.2 respectively. Neither specimen is in good condition; the abdomen of the allotype is contracted and distorted so that the portion of the description referring to the posterior segments applies to another specimen.

Type Locality.—Rye, Colorado.

Hosts.—Seeds of *Abies lasiocarpa* (Hook.) Nutt. and *A. amabilis* (Doug.) Forbes, the latter here reported for the first time.

Variations—Female. The usual extent and character of variation in this species is indeterminable from so few specimens. The type apparently is not typical with respect to either sharpness of sculpture or abdominal color pattern. Larger specimens especially are more coarsely sculptured, including the area behind the transverse line. The stigma varies considerably in shape and may resemble that of *specularis* Wall., or certain specimens of *pinus;* too, the shape at times is very suggestive of the European species, *suspectus* Borr. The infuscation on the face may not be continuous to the gena, and the yellow spot on the side of the pronotum may be considerably more extensive than described. In addition, there may be an indication of a yellow spot beneath the front wing base; the middle coxa may be distinctly yellow on its anterior half; and the dark brown on the hind femur may be reduced, which is especially true on specimens reared from *A. amabilis*. All females examined, except the type, have a yellow spot at the side of tergum IV, and a more extensive yellow spot on terga V to VIII inclusive, being largest and most conspicuous on VI and VII. Variations in size of females seen is as follows: Length, 3.0 mm. to 4.2 mm.; abdomen, 1.5 mm. to 2.9 mm.; ovipositor sheath, 2.8 mm. to 4.0 mm.

Male. The same differences in sculpture may be found in males associated with larger females. Coloration appears to vary even less in the female. Frequently, yellow invades the pleural areas, especially the mesopleurum, and the prepectus may be largely yellow. Some specimens have two small yellow spots on the posterior dorsal margin of the pronotum, and abdominal tergum VIII may be nearly all black. In describing the male, Crosby stated, "Abdomen black"; the abdomen of the allotype is much contracted but close examination revealed the presence of yellow as indicated in the preceding description. According to material examined, the males vary in body length from 2.3 to 3.8 mm.; length of the abdomen varies from 1.1 mm. to 2.0 mm.

Distribution.—Colorado, Washington, Canada (British Columbia).

Comments—Structurally, *lasiocarpae* is very closely related to *pinus,* from which it may be separtted by the jet black of the thoracic dorsum, which has dark vestiture. The male is not easily distinguished from *milleri* (see key). In many respects there is also a close relationship with *specularis* Wall., and especially with the European *suspectus* Borr.

The species appears to be relatively uncommon; only seventeen specimens, including the types, have been available for study.

MEGASTIGMUS SPECULARIS Walley

Fig. 28

Megastigmus specularis Walley, Can. Ent., vol. 64, p. 187, 1932.

Female—Length, 2.8 mm.; abdomen, 1.4. Ovipositor, 2.7 mm. Outline of head from above somewhat transverse oval, about 1⅔ as wide as long; compound eye nearly circular; vertex evenly convex with transverse rugulae

becoming arched anteriorly, and with shallow setigerous punctures laterally; occipital carina weakly angulate above; ocelloccipital line equal to ½ either ocellocular line or posterior ocellar line; antennal scrobe rather shallow but distinctly defined laterally; scape about equal to length of pedicel, ring segment and FI; pedicel oval, distinctly wider and slightly shorter than FI, which is nearly twice as long as wide and only little longer than FII; head otherwise similar to that described for *lasiocarpae*. Pronotum distinctly wider than long, rounded anteriorly, flange on antero-dorsal margin reduced and weakly emarginate, rugae on dorsum more distinct anteriorly and sculpture weaker and less regular posteriorly; mesopraescutum with arched rugulae on anterior half, stronger and more transverse posteriorly; sculpture of mesoscutum and axilla finer and more irregular; scutellum nearly as wide as long and mostly irregularly shingled, behind arcuate transverse line largely reticulate; median piece of metanotum (sometimes conspicuously sculptured) bluntly produced upward at its middle; thoracic vestiture relatively short and fine. Propodeum elevated, (usually) without distinct median carina; carination sharp, irregularly reticulate; groove below propodeal spiracle shallow and not distinctly defined at side; abdomen subcompressed (or compressed), smooth and polished; ovipositor evenly arched upward.

Color black and tawny yellow. Face to middle of inner eye margin, circumorbital band except for interruption on dorso-lateral frontal area, scape and pedicel beneath, tawny yellow; remainder of head black, and antenna brown except lighter beneath. Pronotum at side, and two transverse spots on posterior margin of dorsum, tegula mesially, tawny yellow; prepectus, spot on outer surface of mesoscutum (often yellow, as given in original description), mesepimeron above, somewhat light brown; remainder of thorax black except pleura and mesosternum dark brown; front leg entirely tawny yellow, others brownish yellow except hind coxa almost entirely black. Abdominal pattern not sharply defined (except on some lighter specimens); sterna and basal terga dark brown to black above, remainder of abdomen gradually becoming light castaneous distally above except pale brown on tergum IX, and more or less tawny yellow at side (the close overlapping of the terga obscures the basic pattern evident on lighter specimens as follows: Tergum III (apparent first) entirely, IV except narrow, median lateral yellow incision, basal 1/3 of V and VI, and sterna dark brown to black; remainder of abdomen mostly yellow or brownish yellow except terga V to VII each with rather wide posterior amber band which is paler on successive posterior terga, and tergum IX with brown of varying extent and intensity); ovipositor sheath dark brown to black.

Vestiture on dorsal areas of head, thorax and abdomen, and that on ovipositor sheath dark or black; remainder of vestiture mostly pale. Proximal ⅔ of submarginal vein with about 10 or 11 conspicuous bristles; stigma oval (Fig. 28, left), without surrounding infuscation; stigmal vein (usually) at least as long as stigmal width.

Male—Length, 2.4 mm.; abdomen, 1.2 mm. Head like that of female but not quite as wide; antennal scrobe very shallow; scape medially expanded, subequal to combined lengths of pedicel, ring segment and FI; pedicel ovate, subequal in length to FI which is slightly longer than FII; funicular segments

of about equal width throughout; ocelloccipital line slightly less than ½ posterior ocellar line; sculpture on thorax like that of female. Carination on propodeum irregular; short, irregular median carina present anteriorly; abdomen compressed, smooth and polished, except some posterior terga very finely aciculate.

Color yellow, black and brown. Face, gena, circumorbital band, scape except distally above, and pedicel beneath, yellow; remainder of head black, and antennal segments distad of pedicel brown, paler beneath. Side of pronotum and two hemispherical spots on posterior dorsal margin, outer surface of mesoscutum, tegula, mesopleurum and mesosternum entirely, spot on inner margin of axilla, yellow; remainder of thorax black except indefinite area on ventral margin of metepisternum, and another on metepimeron, yellowish brown; all coxae yellow except hind coxa brown at extreme base; femora yellow; tibiae light brownish yellow; tarsi darker. Abdominal tergum III dark brown above, pale amber at side (side usually appears tawny yellow when terga are closely appressed); terga IV to VII inclusive dark brown above becoming pale amber at posterior border, dorsal pattern on each (either constricted basally, or) narrowly separated from preceding by brownish yellow basal band; remainder of abdomen brownish or tawny yellow except basal sterna light brownish.

Vestiture as in female except somewhat shorter. Proximal ⅔ of submarginal vein with (usually) 9 or 10 conspicuous bristles; stigma (Fig. 28, right) broadly oval (to circular).

Redescribed.—Paratype, female, New Brunswick, Canada, (Ex *Abies balsamea*, Ottawa, Mar. 22, 1938, E. B. Watson); paratype, male, with the same data except reared Apr. 2, 1928. Specimens are in the Canadian National Collection, Ottawa, Ontario, Canada, under number 3390.

Types.—Holotype (female) and allotype are in the Canadian National Collection, Ottawa, Ont., Canada, under number 3390. Type not examined.

Type Locality.—New Brunswick, Canada.

Host.—Seeds of *Abies balsamea* (L.) Mill.

Variations—Female. The sculpture on the thorax is sometimes quite sharp, and the carination of the propodeum is subject to variation. Differences in the shape of the stigma may be noted. The yellow circumorbital band may be weakly interrupted on the temple, and frequently the yellow spots on the posterior dorsal margin of the pronotum are absent. A yellow spot may be present on the outer surface of the mesoscutum (as stated in the original description). The abdominal pattern varies in intensity and in definition. Specimens with a marked pattern on the abdomen show the following condition: Sterna and tergum III entirely dark brown to black; tergum IV dark brown above, with yellow at the side narrowly projecting toward the median dorsal line at about the middle; terga V and VI each with a transverse, dark brown basal spot laterad of the median dorsal line (or taken together, the two spots may form a dark band across the approximate basal 1/3 of the tergum), behind with a transverse, median yellow band, followed by a rather wide amber band; tergum VII entirely yellow except a weaker but distinct posterior amber band; remainder of the abdomen yellow except tergum IX

which usually has a varying amount of brown. The close overlapping of the amber bands gives a castaneous appearance to the dorsal area of the posterior segments. Some specimens have a greasy appearance in which case the yellow becomes very tawny or brownish.

Male. Apparently, males vary considerably in color. The lighter male is described. On darker specimens the following yellow parts are absent: The circumorbital band; the spots on the posterior dorsal margin of the pronotum; the spot on the mesoscutum and that on the axilla. Also, the mesopleurum and the mesosternum, and the hind coxa are black; the side of the pronotum and the middle coxa may have a brownish cast. It is impossible to ascertain the normal range of variations from the few specimens examined in this study.

Distribution.—New Hampshire, Massachusetts, Minnesota, Canada (New Brunswick). Specimens which were very likely collected in Connecticut also have been examined.

Comments—This species, which is a typical member of the *pinus* group, is closely related to *lasiocarpae* Cy. From that species it can be distinguished by the dimensions of the antennal segments, the absence of conspicuous strong vestiture on the inner surface of the scape and on the cheeks, the general tawny yellow body markings, the different abdominal pattern, and the different shape of the stigma (*Cf.* figs. 25 and 28). In addition, females of *specularis* lack the dark infuscation on the hind femur. Males have almost identical markings as do the lighter males of *lasiocarpae*, but the yellow of *specularis* is more golden, and the legs are not nearly as brown. The median piece of the metanotum of both species is black, but in *specularis* it is usually sculptured and drawn upward. The absence of strong vestiture on the inner surface of the scape also applies to separation of the male of this species from that of *lasiocarpae*.

MEGASTIGMUS RAFNI Hoffmeyer

Fig. 27

Megastigmus pinus Parfitt, Zool., p. 5721, 1857 (♂ only): Dalla Torre, Cat. Hymen., vol. 5, p. 287, 1898 (in part, ♂ only).

Megastigmus sp. B. Riley, Proc. Ent. Soc. Wash., vol. 2, p. 360, 1893 (in part).

?*Megastigmus* sp., Judeich & Nitsche, Lehrb. mitteleurop. Forstinsekt., vol. 1, pt. 3, p. 704, 1893; Ibid., vol. 2, p. 4, p. 1339, 1895.

?*Megastigmus strobilobius* Ratz., Rohwer, U.S.D.A. Bur. Ent. Tech. Ser. 20, pt. 6, p. 159, 1913 (in part).

Megastigmus spermotrophus Wachtl, Crosby, Ann. Ent. Soc. Amer., vol. 6, p. 163, 1913 (in part): Gahan, Proc. Ent. Soc. Wash., vol. 24, pp. 40 (in part), 49, 1922: Hoffmeyer, Ent. Meddel., vol. 16, p. 329, 1929; Ibid., vol. 17, p. 217, 1930 (in part): Ibid., vol. 17, p. 265, 1930 (in part): Vayssiere, Rev. path. veg. d'ent. agric., vol. 18, p. 186, 1931 (in part): Escherich, Zeit. f. angew. Ent., vol. 25, pp. 366, 367, 374, 1938 (in part).

Megastigmus rafni Hoffmeyer, Ent. Meddel., vol. 16, p. 331, 1929 (♀ only); Ibid., vol. 17, p. 216, 1930 (♂): Laidlaw, Scot. For. Jour., vol. 45, pp. 189-190, 1931.

Female—Length, 4.2 mm.; abdomen, 2.9 mm. Ovipositor sheath, 4.7 mm. Head broadly oval from dorsal aspect, resembling that of *spermotrophus* but longer; occipital carina sharp, not set deeply into head, extending high on

vertex, and somewhat angulate dorso-medially and dorso-laterally; vertex elevated behind ocelli, smooth to finely striate, striae continuing onto temple and front; ocelloccipital line equal to ocellocular line or ⅔ of posterior ocellar line; antennal scrobe rather shallow, smooth and not distinctly bounded by strong carina; scape about as long as combined lengths of pedicel, ring segment, FI and ½ FII; pedicel little wider and nearly as long as FI, which is cylindrical; funicle of equal width throughout, its proximal segments (FI to FV) each twice as long as wide. Pronotum about as wide as long and from above evenly arcuate laterally, broadly and shallowly emarginate on anterior dorsal flange, dorsum with sharp, transverse irregular rugae; mesopraescutum finely rugulose anteriorly, behind with more transverse rugae which continue onto mesoscutum; rugulae of scutellum mostly transverse and irregular, area behind transverse line shallowly reticulate (variable); hind tarsus about ¾ as long as hind tibia; dorsal measurement of first hind tarsal segment distinctly longer than entire length of second segment (or the entire length of the first hind tarsal segment approximately twice the dorsal measurement of the second segment); vestiture on thoracic dorsum comparatively fine, stiff, of medium length, that on scutellum (usually) restricted to two lateral rows. Propodeum elevated, with irregular carination, its posterior half bounded laterally and posteriorly by variable arcuate carinae more or less enclosing larger oblique ones which originate at median posterior margin; median carina present but weak; short groove below propodeal spiracle interrupted by transverse carina; abdomen compressed, polished, with fine, relatively sparse vestiture; ovipositor evenly arched upward.

Color light to brownish (or greenish) yellow with brown or black markings. Head brownish or tawny yellow; triangular patch laterad of clypeus attaining antennal base, small circular patch dorsad of clypeus, and spot on postgena, dark brown; ocelli narrowly but entirely surrounded by dark brown or black; scape tawny yellow except distal end and remainder of antenna dark brown to black. Pronotum pale brownish yellow (but normally on fresh specimens lemon to greenish yellow); mesopraescutum with anterior area (approximate 1/3) black, shading to lighter brown or brownish yellow medially behind, remainder lighter (greenish) yellow being concolorous with outer and inner margins of mesoscutum, inner angle of axilla, and scutellum, outer anterior angle of axilla about as dark as anterior mesopraescutal margin; mesoscutum with indefinite, oblique brownish yellow area dorsally; depression on mesopleurum mostly dark brown; median piece of metanotum brownish (greenish) yellow, remainder of metanotum mostly brown; hind and (usually) middle coxae with some brownish color on outer surface, remainder of coxae and femora light tawny yellow, approaching predominating color of thorax; tibiae and tarsi somewhat darker. Propodeum mostly light brownish (or greenish) yellow except black anteriorly; abdomen brownish yellow with dark (or black) stripes; tergum III (apparent first) brown; terga IV to VII inclusive each brownish yellow with distinct lateral oblique, dark brown stripe (stripe on tergum IV directed obliquely caudad, on others usually more dorsad) narrowing and converging on median dorsal line, being most pronounced on IV to VI inclusive; remaining terga mostly brownish yellow

(stripes on terga IV to VI are successively less distinct, and being less extensive rarely converge on median dorsal line; they may be reduced to mere lateral spots); ovipositor sheath black.

Vestiture on dorsum of head, thorax and abdomen, on ovipositor, front femur and distal end of middle femur, row on outer surface of front tibia and most on middle tibia, black; remaining conspicuous vestiture pale. Wing hyaline and glassy, with finer (usually) less abundant, shorter vestiture than on *spermotrophus* wing; stigma (Fig. 27, left) elongate-oval, slightly bent mesad and directed toward inner wing margin, without surrounding clouded area and narrower at junction with stigmal vein which is about as long as stigmal width; proximal ⅔ of submarginal vein with 14 to 16 conspicuous bristles.

Male—Length, 3.0 mm.; abdomen, 1.4 mm. Head nearly twice as wide as long; elevation of vertex and sculpture similar to that of female; ocelloccipital line equal to ocellocular line or slightly more than ½ posterior ocellar line; scape about as long as combined lengths of pedicel, ring segment and FI; pedicel as wide or wider than FI which is equal or subequal to FII; funicular segments approximately twice as long as wide, all of about same width; antennal scrobe rather shallow, not bounded by distinct carina. Pronotum nearly as long as wide, shallowly emarginate on anterior dorsal flange, crossed by prominent rugae; sculpture of remainder of thorax similar to that of female (except more conspicuous longitudinal median depression on the scutellum); hind tarsus and its basal segment with about same relative lengths as in female. Propodeum irregularly carinate, without strong median carina (if present, usually not more distinct than lateral arcuate carinae); latero-posterior region well defined by noticeable flange-like, arcuate carina; groove below propodeal spiracle not sharply defined; abdomen compressed; tergum III polished and smooth, others very finely aciculate.

Color and pattern similar to that of female except triangular median dorsal spot of varying extent on anterior margin of pronotum, approximate outer half of axilla, extreme side of scutellum, area in proximity of transverse line (sometimes also along entire median longitudinal axis of scutellum, and parapsidal furrow), and most of metanotum, dark brown to black; median piece of metanotum yellow; legs tawny yellow except coxae more nearly concolorous with pleura. Approximate anterior third of propodeum brown to black, remainder yellow; tergum III dark brown medially above, brownish yellow shading to pale amber laterally; terga IV to VII each brownish yellow except conspicuous median dorsal brown spot at base of VII, and each with posterior amber band slightly more intensified above, especially on IV (some may have continuous dark brown to black stripe extending over most of median dorsal areas of terga III to VII inclusive); remaining terga and sterna brownish yellow.

Color and character of vestiture like that of female. Stigma more oval (Fig. 27, right); stigmal vein nearly equal to stigmal width; proximal ⅔ of submarginal vein with about 11 to 12 conspicuous bristles.

Redescribed from a female, Mt. Maniyou, Colorado, Sept. 28, 1916, J. H. Pollock

(Reared, *Abies conoclor*, 14212BB Hopk. U.S.); and a male, Beulah, Colorado, Oct. 9, 1916, P. D. Sergent (Reared, *A. concolor*, 10842h Hopk. U.S.). Specimens are in the collection of the University of Minnesota. A paratype female (U.S.N.M. No. 41767) in the collection of the U. S. National Museum was also examined.

Type.—A female, in Hoffmeyer's collection, Copenhagen, Denmark.

Type Locality.—Central [Western] United States.

Hosts.—*Abies* spp. Established host species are: *A. concolor* Lindl. & Gord., *A. grandis* Lindl., *A. magnifica* Murr., and *A. magnifica* var. *shastensis* Lemm.

Heretofore, *spermotrophus* Wachtl has been reported from the seeds of *Abies* spp. but undoubtedly those records refer to *rafni*, because all specimens of the former species examined have come from the seeds of *Pseudotsuga*, without what is believed to be a single exception. Hoffmeyer's 1930 record of one female *rafni* from *Pseudotsuga taxifolia*, and another record of a female (Quill IB, U. S. National Museum) in the original shipment of material from Borries need confirmation.

Variations—Female. This species appears to be about as variable as *pinus*. The sculpture on the head is sometimes nearly obliterated and the elevation on the vertex may be only scarcely discernible, particularly on smaller individuals. The propodeum may appear reticulate with the median carina weaker anteriorly; on others the carination is markedly weaker over the entire surface. The propodeal carination of some may superficially approximate that of *pinus*. The females vary in size as follows: Length, 2.3 mm. to 5.5 mm.; abdomen, 1.2 mm. to 2.5 mm.; ovipositor sheath, 3.0 mm. to 6.9 mm.

In keeping with most members of the genus, the color pattern of this species is very variable. Lighter individuals may be like *spermotrophus* in superficial appearance, in which case the brownish area on the mesothorax becomes yellowish; such individuals have the head, the anterior portion of the scutellum, the dorsal surface of the mesoscutum, the anterior surface of the axilla, the mesosternum, the tarsi and the tibiae somewhat, orange or golden yellow; other parts of the body are lighter yellow, and the antennae vary from light to dark brown. The dark oblique stripe on the second abdominal tergum, although reduced, is usually visible on most of the lighter specimens, being absent, or nearly so, on the remaining terga. The darkest specimens examined are near the typical but the markings are more intense and more extensive.

Male. Males also vary greatly in intensity of color pattern. Often the brown is considerably more extensive and darker, giving a superficial brown appearance to the entire specimen except where the color is consistently lemon or greenish yellow, such as on the posterior and lateral areas of the pronotal dorsum. A few specimens have dark brown on most of the dorsum of the pronotum and mesonotum, as well as a median dorsal brown stripe on the abdomen as indicated in the description; such dark specimens have the posterior areas of the propodeum lighter. Other males appear almost entirely yellow except for the black on the outer half of the axilla (or the anterior margin of the axilla), anterior areas of the mesopraescutum and propodeum, and the basal abdominal segments. The antennae are usually lighter than those of the female. Males vary in size as follows: Length, 2.3 mm. to 3.7 mm.; abdomen, 0.5 mm. to 1.76 mm.

A series of 47 specimens reared from the seeds of *Abies grandis* was studied and referred to this species after some reluctance to do so. Certain

structural deviations from typical *rafni* are obvious within the series. Thus, as already indicated, there appear to be variations concerning both color and structure comparable to those described for *pinus*. As a group, these specimens are smaller, less distinctly sculptured, and the relative length of the first segment of the hind tarsus is somewhat shorter than in typical *rafni*. Although the relative length of the ovipositor sheath is not constant, it is still distinctly, or at least perceptibly, longer than the body. Some individuals have the distal segments of the funicle successively widened, and the scutellum may be rather broad near the middle but noticeably narrowed anteriorly. The color is very much like that previously indicated for the yellow variants of *rafni*. Only a few of these specimens have brown markings, but when these are present they are most evident on the abdomen, appearing indefinitely diffused on the dorsum or as oblique lateral stripes, or both. Males are like typical individuals except that they are smaller, more tawny yellow (or brownish yellow).

This extreme variation, as well as other differences in color and structure that may be encountered, may cause some difficulty in attempts to distinguish readily between *rafni* and *spermotrophus*. One or more of the following features that are common to *rafni* may assist in separating the more difficult individuals of the two species: Head rotundate, with the vertex somewhat strongly convex or elevated behind the ocelli; basal segment of the funicle cylindrical, or of equal width throughout, and similar to the following two or three segments which are about twice as long as wide; thorax comparatively (narrower and) more elongate, not as compact as in *spermotorphus;* ovipositor sheath longer than the body, usually distinctly so. When dark oblique, stripe-like markings occur on the abdomen they may be relied upon for separation of the females of *rafni*.

More typical females of this species may be separated readily from those of *spermotrophus* by their longer ovipositor sheath, longer first segment of the hind tarsus, and difference in coloration. Males of *rafni* may be separated by their greenish yellow and black coloration; the outer half of the axilla is black, which is rarely reduced to only a brown spot on the anterior margin; usually the posterior two-thirds of the propodeum is yellow.

Distribution.—California, Colorado, Idaho, New Mexico, Oregon, Canada (British Columbia).

Comments—Hoffmeyer's original description refers to the dark form reared from the seeds of *Abies concolor*. The sexes were described in separate papers but were correctly associated. The superficial resemblance of larger and lighter specimens of *rafni* to *spermotrophus* is very striking but the two species are structurally distinct. Heretofore, the two have been confused, and prior to 1929 specimens of what is now regarded as *rafni* were, with few exceptions, referred to *spermotrophus*. *Rafni* appears to be nearest to the variable *pinus*, yet it is entirely distinct from that species.

Parfitt (1857b) described what he believed to be the male of *pinus*, having previously reared and described only the female. According to Crosby (1913), C. O. Waterhouse, of the British Museum (N. H.), compared supposed

spermotrophus males with Parfitt's types and sent them to Crosby, who concluded that the male described by Parfitt did not belong to *pinus*, but was in reality the male of *spermotrophus*. However, there is little doubt but that Parfitt had the male of *rafni* before him since the description in question seems to fit the male of that species and not *spermotrophus*. The *spermotrophus* of Crosby and of most subsequent authors was a composite species, consisting of the two under discussion.

It is interesting to note that Riley (1893) at an early date suggested the possibility that two species were mixed when he referred to one lot of Borries' material in which were contained specimens reared from *Abies* spp. and *Pseudotsuga taxifolia*.

The *Megastigmus* sp. from *Abies amabilis* (California) referred to by Judeich and Nitsche (1893, 1895) as being then undescribed is very likely this species because of the similarity to *spermotrophus* that was inferred when they said: "The species [*M. spermotrophus*] does not appear identical to us with the one we reared from the seeds of *Abies amabilis* Dougl." (Translation). Rohwer (1913) referred this record to *M. strobilobius* Ratz., and Escherich (1938) suggested it might belong to *M. pinus* (var. *Crosbyi* Hoffmeyer).

MEGASTIGMUS ALBIFRONS Walker

Fig. 22

Megastigmus albifrons Walker, Trans. Ent. Soc. Lond., p. 314, 1869 (♂ only): Notes on Chalcid., Pt. 2, p. 28, 1871: Dalla Torre, Cat. Hymen., vol. 5, p. 285, 1898: Schmiedeknecht, Gen. Insect., fasc. 97, p. 119, 1909: Crosby, Ann. Ent. Soc. Amer., vol. 6, p. 167, 1913 (♂ & ♀): Gahan, Proc. Ent. Soc. Wash., vol. 24, pp. 39, 52, 1922.

Female—Length, 6.5 mm.; abdomen, 2.9 mm. Ovipositor sheath, 4.7 mm. Outline of head from above hemispherical, nearly 1⅔ times wider than long; vertex weakly convex with rather sharp transverse, arched rugae; type of sculpture on face similar to that of other species but sharper; gena weakly rugulose to reticulate below eye; length of malar space fully ⅔ to nearly 4/5 height of compound eye which is oval and moderately bulging; frontogenal suture weak below; occipital carina sharp, evenly arched above, attaining top of vertex or nearly so; ocelloccipital line only slightly greater than ½ ocellocular line, or about ½ posterior ocellar line; antennal scrobe shallow but deeper below and sharply rugulose above; scape curved, slightly longer than combined lengths of pedicel, ring segment, FI and FII; pedicel elongate-oval, wider than, and almost as long as FI which is about three times as long as wide; FII subequal to FI and each remaining funicular segment successively shorter, all about of equal width. Thorax roughly sculptured; pronotum little wider than long, its dorsum with coarse transverse rugae, rather abruptly transversely elevated on anterior third and with weaker elevation at posterior margin, flange on dorsal margin rather weak and shallowly emarginate; mesonotum traversed by coarse rugae except axilla irregularly obliquely rugulose, and scutellum behind transverse line longitudinally rugulose; femora swollen; head and thorax with numerous, relatively long coarse hairs each arising from brown

base, those on scutellum rather evenly distributed laterad of median line. Propodeum without median carina (distinct, sharp median carina may be present), lateral arcuate carinae strong, irregular; propodeal spiracle large, irregularly oval, groove below rather short and traversed by rugae; abdomen compressed, smooth, polished; ovipositor evenly and strongly arched upward.

Color dull yellowish to yellowish brown and black. Small spot at side of clypeus and another extending laterad from antennal base, brown; occiput and large spot on vertex extending into antennal scrobe and laterad in shape of wedge nearly to dorsal margin of eye, black; remainder of head tawny to brownish yellow except posterior region of temple darker; scape tawny yellow beneath, dorsal surface especially, brown; remainder of antenna dark brown to black. Pronotum brownish yellow suffused with darker brown especially on anterior dorsal area, having median dorsal wedge-shaped black spot with its apex attaining posterior margin, and slightly arched longitudinal black stripe on latero-dorsal area (latter frequently extends from posterior margin and unites with median dorsal spot just behind anterior transverse elevation); mesopraescutum black except brownish yellow at side; mesoscutum brownish yellow suffused with darker brown above; axilla black except inner angle and outer surface; scutellum with wide dorsal black stripe broadened at transverse line then abruptly narrowed near posterior margin (frequently also attenuated just anterior to transverse line), remainder of scutellum, metanotum largely, and pleura except brownish spot beneath front wing base, brownish yellow suffused with darker brown; front coxa dull yellow, its posterior surface and other coxae somewhat darker to brownish; remainder of legs dull yellow suffused with brown except tibiae light brown and tarsi darker. Propodeum black except indefinite patch on posterior lateral margin brownish yellow; abdominal tergum III (apparent first) entirely, and most of dorsal area of others, dark brown; posterior area of side on terga IV to VII inclusive brown, remainder of side brownish yellow which is more extensive especially dorsad on terga V to VII; tergum VII nearly entirely brownish yellow; last tergum brown above, yellowish below; sterna somewhat light brown; ovipositor sheath black.

Vestiture on head except below antennal bases, antenna except scape beneath, dorsum of thorax and abdomen, ovipositor sheath, and few strong hairs on legs, dark; remaining vestiture mostly pale. Wing hyaline except infuscated spot adjoining posterior margin of submarginal vein beyond basal vein; proximal 2/3 of submarginal vein with about 18 to 20 strong bristles; stigma large, elongate-oval (Fig. 22, left) and somewhat acutely rounded on ventral margin.

Male—Length, 6.0 mm.; abdomen, 2.5 mm. Shape of head and sculpture of body very similar to that of female; scape curved, expanded distally, equal to pedicel, ring segment, FI and about 1/3 FII; pedicel about 4/5 as long as FI which is about equal to FII, remaining funicular segments successively shorter, all of about equal width. Sculpture on scutellum behind transverse line weaker, more or less reticulate or rugulose; front and hind femora more swollen; vestiture on thorax very much like that of female. Carination of propodeum, especially arcuate lateral carinae, somewhat weaker; abdomen

(nearly always) depressed; abdominal terga III and IV smooth, remaining terga very finely aciculate.

Color very similar to that of female except more extensively lighter. Head without infuscation on face, gena and temple; latero-dorsal arched stripe on pronotum reduced (often absent); median black stripe on thoracic dorsum narrower; black on mesoscutum largely restricted to anterior margin; middle and hind coxae lighter; otherwise color of head, thorax and legs similar to that of female. Abdominal tergum III black above, brown at side; remaining terga black above, side of each brownish yellow bordered posteriorly and ventrally by pale amber band.

Color of vestiture like that of female. Wing hyaline except infuscated spot behind distal end of submarginal vein as in female; proximal ⅔ of submarginal vein with 15 to 20 strong bristles; stigma more broadly oval (Fig. 22, right), somewhat angulate or expanded on mesal margin and surrounded by narrow, pale infuscation.

Redescribed from a female, Placerville, Calif., Feb. 8, 1913, J. M. Miller (*Pinus ponderosa*, 1145a Hopk. U.S.); and a male, with the same data. Specimens are in the collection of the University of Minnesota.

Type.—Male, in the collection of the British Museum (N.H.) London. Type not examined.

Type Locality.—California.

Host.—Seeds of *Pinus ponderosa* Laws.

Variations—Female. This species appears to be rather constant in structure. As indicated in the description, the malar space may vary in length from ⅔ to 4/5 the height of the compound eye. The rugosity on the dorsum of the head is sometimes very irregular or the sculpture may be more extensively and coarsely punctate, especially on the ocellar region. A regular, sharp median carina may be present on the propodeum, which is variably sculptured. The shape of the stigma and the infuscation surrounding it are quite variable. One small female examined does not possess an infuscated spot beneath the distal end of the submarginal vein. The darkest females examined have the lateral pronotal stripe continguous with the median spot anteriorly, and have most of the anterior part of the mesopraescutum black in the form of a wedge directed caudad, while on others the stripe on the mesopraescutum is medially attenuated. The scutellum of some appears nearly entirely black except at the extreme side and posterior margin. Dark brown may sometimes appear at the sides of the abdominal terga and diffuse with the yellowish pattern, giving a general castaneous appearance to the abdomen. Lighter specimens may show a distinct whitish cast, especially on the face, parts of the pleura and on the front coxa. The variation exhibited on the thorax of lighter specimens concerns chiefly a narrowing of the dorsal longitudinal black stripe. However, some individuals have very distinct, lighter abdominal coloration, and the shape and location of the dark markings somewhat resemble the condition found in *pinus* Parf. Such abdominal coloration is briefly described as follows: Tergum III brown to black above with a trace of brownish yellow laterally at the base, bordered ventrally and posteriorly by a brown margin; tergum IV brown except a more definite yellow

spot in the same location, bordered as on tergum III but more definitely so and with a faint incision of brown invading the yellow area on its anterior margin; this brown incision, which is directed caudad and occupies approximately the same relative position as does the spiracle on tergum VIII, is very conspicuous on terga V and VI but practically disappears on VII; lateral yellow spots become successively larger on terga IV to VIII, leaving a wedge-shaped brown pattern on the dorsal posterior margin of this tergum. Light hairs may occur on the thoracic dorsum intermixed with the usual black ones. Females examined vary in size as follows: Length, 3.4 mm. to 6.9 mm.; abdomen, 1.6 mm. to 3.0 mm.; ovipositor sheath, 2.6 mm. (approximate) to 5.0 mm. Most specimens conform in size to the dimensions given in the description.

Male. Males appear to be less variable. As in the female, the proportionate lengths of FI and FII are subject to slight deviations, and a distinct median carina may be present on the propodeum. The shape of the stigma does vary considerably; the stigmal sector of some is shorter and blunter. Some specimens have the abdomen decidedly compressed but with the majority it is depressed. Males range in size as follows: Length, 5.1 mm. to 6.4 mm.; abdomen, 2.3 mm. to 2.6 mm. Coloration is rather constant throughout the series studied except that the dorsal longitudinal black stripe may be considerably narrowed.

Distribution.—Arizona, California.

Comments—Albifrons is the most distinct species in the genus. In almost all important structural aspects of both sexes it can be separated without difficulty from all other members. Its position in a phylogenetic scheme is uncertain because of its remote structural relationship with other known species except *formosus*, n. sp., which appears to be the most closely related. Though *albifrons* is in many respects not closely related to this species, the two do exhibit characters in common, and are here placed together in the *albifrons* group. *Albifrons* may be distinguished from *formosus*, by its more compact body, shorter ovipositor sheath than the total length, shape of the stigma, and the presence of an infuscated spot behind the distal end of the submarginal vein, in addition to numerous other obvious differences given in the description.

Megastigmus formosus n. sp.

Fig. 23

Female—Length, 4.0 mm.; abdomen, 1.9 mm. Ovipositor sheath, 5.0 mm. Outline of head from above somewhat semicircular, slightly less than 1½ times as wide as long; vertex depressed, weakly transversely rugulose posteriorly with few shallow pits intermixed; face and gena finely and weakly sculptured; length of malar space distinctly greater than ½ height of compound eye which is oval and moderately bulging; occipital carina very prominent and sharp, broadly arched above, attaining top of vertex, and somewhat angulate dorso-laterally; ocelloccipital line about equal to ocellocular line or little less than ⅔ posterior ocellar line; antennal scrobe moderately deep, not abrupt laterally but at most defined by delicate carina, above attaining anterior

ocellus; scape thickest basally, slightly curved, tapered distally, equal to combined lengths of pedicel, ring segment, FI and ½ FII; pedicel elongate-rectangular, distinctly wider and longer than FI which is about of uniform width throughout, fully twice as long as wide and slightly longer than FII; FII and FIII about equal, each nearly twice as long as wide; remaining funicular segments only little shorter and each only very gradually increasing successively in width; vestiture on head not especially long and stiff, densest on face. Pronotum as long as wide with flange on anterior dorsal margin weakly emarginate, dorsum with transverse depression on posterior half (somewhat as in *albifrons*) and with sharp, coarse transverse rugae becoming weaker laterally and on posterior margin which is abruptly defined; mesopraescutum and mesoscutum traversed by sharp, coarse, continuous rugae somewhat finer and slightly arched on anterior area of former; axilla with fine obliquely arched rugulae, coarser at inner margin; scutellum depressed, crossed by sharp rugae most of which are irregularly transversely arcuate (or somewhat longitudinal) behind position of transverse line (almost entirely obscured except laterally); median piece of metanotum with irregular transverse undulate or curved rugae; dorsum of thorax rather evenly covered with relatively long, strong hairs, those on scutellum restricted to irregular row very near lateral margin. Propodeum conspicuously elevated, with coarse, irregular reticulate sculpture; sharp median carina present anteriorly and strong irregular oblique carina extending from posterior and anterior margins; groove below propodeal spiracle deep, rather distinctly defined and traversed by several rugae; abdomen compressed, smooth and polished, and with sparse vestiture; ovipositor not strongly but evenly arched at base, inclined upward.

Color mostly tawny brownish yellow (or tawny yellow) and black; median dorsal area of head, thorax and abdomen black, forming superficially continuous, longitudinal stripe. Ocellar area and area of approximately same width extending to occipital carina, antennal scrobe above, wedge-shaped extension from lateral ocellus nearly to dorsal margin of eye along ocell-ocular suture, and occiput above, black; remainder of head tawny brownish yellow or ochraceous except face below antennal bases including spot on clypeus, and transverse patch on postgena deeply infuscated with brown (indefinite area on cheek and another below eye very faintly infuscated); antenna dark brown to black with approximate basal ⅔ of ring segment yellowish. Pronotum with median dorsal longitudinal black stripe broader on anterior half; remainder of pronotum tawny brownish yellow except indefinite infuscated spot on lower anterior margin of side; extreme side of mesopraescutum along parapsidal furrow, mesoscutum almost entirely, axilla except extreme inner angle and antero-lateral brownish infuscation, extreme side and posterior margin of scutellum, tegula, mesopleurum, and mesosternum except brownish infuscation, tawny brownish yellow; remainder of mesothoracic dorsum black, forming wide longitudinal stripe continuous with that on pronotum; metathorax tawny brownish yellow except metanotum in part, and dorsal ¾ of metepisternum dark brown (median piece of metanotum more nearly tawny yellow); legs mostly concolorous with lighter body parts except middle coxa faintly on posterior basal surface, and hind coxa on basal half, brownish. Propodeum mostly black;

abdominal tergum III (apparent first) dark brown to black; terga IV to VII inclusive dark brown to black on entire median dorsal area forming continuous longitudinal stripe, side of each tergum tawny yellow (to tawny yellowish brown) with broad amber posterior border (which imparts light castaneous appearance to some or most of side of abdomen); tergum VIII mostly concolorous with sides of preceding terga except brown above interrupted along median dorsal line, and brown narrowly projecting anteriorly from spiracle; last tergum mostly yellowish brown, darker above; sterna brown (or amber); ovipositor black.

Vestiture entirely pale except that on wing and ovipositor sheath dark. Proximal ⅔ of submarginal vein with about 13 conspicuous bristles; stigma somewhat oval (Fig. 23) with narrow surrounding infuscation; stigmal vein relatively short.

Male—Unknown.

Types.—Holotype, female, Ottawa, Ontario, July 21, 1938, A. Brooks. Holotype in the Canadian National Collection, Ottawa, Canada. Paratypes: 4 females, with same data as holotype; 1 female, Britannia, Ontario, July 2, 1937, G. A. Hobbs; 1 female, Ste. Anne's, Quebec, July, 1913. Paratypes are in the Canadian National Collection, the collection of the University of Minnesota, and the collection of the U. S. National Museum.

Type Locality.—Ottawa, Ontario, Canada.

Host.—Unknown.*

Variations—Considerable structural variations may be noted in this species. The eye varies in size and the length of the malar space is sometimes fully ⅔ of its height. The rugae on the extreme posterior dorsal area of the scutellum may sometimes be more nearly longitudinal than transversely arcuate. The carination on the propodeum is variable in coarseness but in general the same type of sculpture occurs on all specimens seen; on none is there a straight, complete median carina; the sharp anterior carinae are sometimes less strongly arcuate and nearly transverse. The number of strong hairs or bristles on the proximal ⅔ of the submarginal vein ranges from 10 (on small specimens) to 14. Differences in the shape of the stigma are also obvious. The size of specimens in the type series is as follows: Length, 3.2 mm. to 4.2 mm.; abdomen, 1.5 mm. to 2.1 mm.; ovipositor sheath, 3.6 mm. to 5.0 mm.

In general, the color pattern appears to be fairly stable. However, the following variations may be noted: The tawny brownish yellow on the head, mesopleurum and side of the abdomen sometimes appears deeper brownish; the scape and pedicel may sometimes have much yellowish brown; the dark brown or black on the vertex may extend nearly to the eye, or it may be confined to the ocellar area; the occiput is sometimes nearly all brownish black; the longitudinal dorsal stripe on the thorax is variable in width, especially on the pronotum; the axilla is sometimes mostly brown on the basal ⅔; sometimes a conspicuous median brownish stripe is present on the anterior surface of the hind femur, and a very pale infuscation on the posterior surface of the

* Recent examination of additional material of this species has revealed the possible host to be seeds of *Crataegus* or *Rosa*.

front femur; the dorsal stripe on the abdomen varies from castaneous to black and usually is less intensive in color posteriorly, and may be very weak or absent on terga VIII and IX; as stated above, the side of the abdomen may have considerable light brown (due in part to the close overlapping by the amber borders of the terga). The specimen from Quebec has the same pattern as described but the yellow areas are more extensive and considerably lighter (more nearly tawny yellow) especially on the pronotum; also, the dorsal stripe on the abdomen is much weaker, being brown to light brown instead of black.

Comments—This attractive species is not very closely allied with any of our previously described Nearctic species. Its nearest relative appears to be *albifrons*, which it resembles with respect to several characters: The long, slightly bent scape; the shallow transverse depression over the posterior half of the pronotal dorsum; the sharp, coarse rugosity; and the shape of the stigma — all are points suggesting at least a distant relationship. It is easily separated from *albifrons*, however, by the ovipositor sheath being longer than the total length, the absence of a spot in the wing behind the distal end of the submarginal vein, the entirely pale body vestiture, and the more vivid color pattern. This species also superficially resembles *nigrovariegatus* Ashm. but it is entirely distinct from that species.

Megastigmus floridanus n. sp.
Fig. 15

Female—Length, 2.6 mm.; abdomen, 1.0 mm. Ovipositor sheath, 0.9 mm. Head rather long, from above more or less sub-ovate; vertex weakly convex, finely transversely rugulose; face finely sculptured, gena practically smooth; length of malar space slightly more than 1/3 height of compound eye which is nearly circular and moderately prominent; occipital carina distinct, evenly arched above and attaining top of vertex; ocelloccipital line distinctly longer than either ocellocular or lateral ocellar lines, or about 7/10 as long as posterior ocellar line; antennal scrobe just attaining anterior ocellus, moderately deep, not abruptly defined laterally, with sharp carina between antennal bases; scape nearly as long as pedicel, ring segment, FI and FII; pedicel oval, almost equal to FI; ring segment comparatively large, nearly as wide as FI which is cylindrical, fully twice as long as wide and about as long as FII; each successive funicular segment gradually wider and very slightly shorter; vestiture on head moderately long and strong, that on face much shorter and finer except strong hair at side of clypeus. Pronotum relatively narrow, almost as long as wide, dorsum with prominent transverse rugae and distinct flange on anterior dorsal margin without perceptible emargination; anterior area of mesopraescutum finely reticulate-rugulose, behind with rather regular transverse rugae continuing across mesocutum; scutellum relatively broad, its anterior margin truncately rounded, with reticulate-rugulose or shingled sculpture to transverse line, behind mostly reticulate-punctate; dorsal measurement of first segment of hind tarsus fully twice dorsal measurement of second segment; vestiture of thorax somewhat sparse, comparatively long and strong, scutellar

hairs restricted to row very near lateral margin. Propodeum with delicate median carina, lateral arcuate carina stronger and enclose finely reticulate-punctate area; groove below propodeal spiracle short and not well defined; abdomen subcompressed, smooth, polished, with sparse, fine vestiture; ovipositor sheath rather narrow, evenly curved upward.

Color brownish yellow. Head entirely brownish yellow; flagellum light brown. Thorax entirely brownish yellow except along posterior dorsal margin of pronotum, indefinite areas on posterior margin of mesopraescutum, inner margin of mesoscutum, circular spot beneath front wing base and most of scutellum, somewhat lighter; legs mostly concolorous with thorax. Abdominal tergum III (apparent first) and sterna light brown; terga IV and V yellowish basally above, remainder light brownish except somewhat paler on extreme posterior margin; remaining terga lighter or brownish yellow; ovipositor sheath dark brown to black.

Vestiture on dorsum of head and thorax, abdomen, ovipositor sheath, and few hairs on legs and some on antenna, dark; remaining vestiture mostly pale except strong hair at side of clypeus dark. Basal vein pale; stigma oval (Fig. 15), without surrounding infuscation; stigmal vein and stigmal sector short; proximal ⅔ of submarginal vein with 8 strong hairs.

Male—Unknown.

Type.—Holotype, female, Osceola, Fla., Aug. 7, 1929, J. J. Kirkland, "Florida Fruit Fly Trap Survey." Holotype in the collection of the U. S. National Museum.

The type is not in perfect condition; the abdomen is broken off between the third and fourth segments and mounted on its side on the same card point; and the fourth and fifth segments of a hind tarsus are missing.

Type Locality.—Osceola, Florida.

Host.—Unknown.

Comments—The structural characters of this species suggest a relationship with the European *pistaciae* Walk. It is distinctly different from any described Nearctic species. Shape of the head, size and shape of the scutellum, chaetotaxy, sculpture of the propodeum, shape of the stigma and type of ovipositor, all show similarity to *pistaciae*.

This species can be distinguished from all other Nearctic species by the combination of the following characters: Long first segment of the hind tarsus; relatively thick, compact head; shape of the stigma; and the entirely yellow color.

UNRECOGNIZED NEARCTIC SPECIES AND VARIETIES

MEGASTIGMUS FLAVIPES Ashmead (nec Ashmead, 1888)

Megastigmus flavipes Ashmead, Trans. Amer. Ent. Soc., vol. 13, p. 128, 1886: Cresson, Trans. Amer. Ent. Soc., suppl. vol., p. 236, 1887: Dalla Torre, Cat. Hymen., vol. 5, p. 287, 1898: Schmiedeknecht, Gen. Insect fasc. 97, p. 119, 1909: Crosby, Ann. Ent. Soc. Amer., vol. 6, p. 166, 1913; Ent. News, vol. 25, p. 27, 1914: Vayssiere, Rev. path. veg. d'ent. agric., vol. 18, p. 185, 1931: Laidlaw, Scot. For. Jour., vol. 45, p. 191, 1931.

(Original description)

"Male—Length, .12 inch. Head and thorax bright golden green, face finely reticulately strigose; thorax irregularly, transversely, coarsely strigose; antenna clavate, scape and flagellum beneath yellow, flagellum above brown-black; the collar is rather short; the scutellum at tip is divided by transverse suture and with a raised rim at border posteriorly; abdomen ovate, black; legs waxy yellow; wings hyaline, veins pale, excepting the stigmal vein, which is brown, and ends in a circular stigma.

"Described from one specimen taken in August."

Type.—The pin with card point bearing remnants of type is in the collection of the U. S. National Museum. The hind legs and a front wing are all that remain.

Type Locality.—Jacksonville, Florida.

Host.—Unknown.

Comments—This species is known only from the original description and the remnants of the unique type male. The description is far from being adequate enough to be sure of the proper position of this species. Ashmead's remark that "the collar [=pronotum] is rather short" suggests that it may not be a *Megastigmus* in the strict sense. On the other hand, the somewhat large, circular stigma surrounded by a rather narrow clouded area, and other features are true megastigmine. The stigma is similar to that found in the male of *M. dorsalis,* a metallic European species.

MEGASTIGMUS PINUS var. MARGINATUS Hoffmeyer

Megastigmus pinus var. *marginatus Hoffmeyer,* Ent. Meddel., vol. 17, p. 216, 1930: Laidlaw, Scot. For. Jour., vol. 45, pp. 188 et seq., 1931.

(Original description)

"Differs from the male of *M. pinus* by the coloration of the abdomen, which has the hind margins of the dorsal segments and the lateral margins of the dorsal segments and the hind margins of the ventral segments slight brown."

Type.—Male, in Hoffmeyer's collection, Copenhagen, Denmark. Type not seen.

Type Locality.—Oregon.

Host.—Seeds of *Abies grandis* Lindl.

Comments—This variety was described from a unique male. None of the specimens studied agree with the description of the abdominal pattern as given. It is possible that *pinus* var. *marginatus* may be the male of *milleri,* n. sp.

MEGASTIGMUS VARIEGATUS Strand

Megastigmus variegatus Strand, Wien. ent. Ztg., vol. 30, p. 93, 1911.

(Original description)

"Drei ♀ ♀ von Mexiko (v. Schlechtendahl).

"Scheint mit M. *spermotrophus* Wachtl nahe verwandt zu sein, unterscheidet sich aber

unter anderem durch bedeutendere Grösse, in Mitte bräunlich gefarbte Scheide des Bohrers, dieser ist kürzer als der Körper etc.

"Gelb gefärbt; schwarz oder dunkelbraun sind; Ozellenfeld (beiderseits der vorderen Ozelle scheint die helle Farbund erhalten zu sein), bisweilen zwei verwischte Flecke auf dem Scheitel, der Fühlerschaft scheint oben schwarzlich zu sein [die Geissel der Fühler ist an allen drei Exemplaren abgebrochen!], Pronotum jederseits mit einem kleinen Längsstrich, eine schmale Vorderrandsbinde auf dem Mesonotum, die Parapsidenfurchen, ein verwischter Fleck auf den Scapulae, der Vorderrand der Axillae, ein verwischter Medianlängsfleck auf dem Scutellum, die Seiten des Dorsulum, eine Basalbinde auf dem Metanotum und eine schmälere Seiten- und Hinterrandbinde ebenda, ein grosser Dorsalfleck auf dem ersten Abdominalsegment, die folgenden Rückensegments sind mit unbestimmt begrenzten bräunlichen oder schwarzlichen Querwischen gezeichnet, wodurch wahrscheinlich bisweilen der ganz Rücken schwarzlich erscheint, wohl mit Ausnahme der beiden letzten oder vorletzten Segmente; die gelben Partien des Abdomen erscheinen meistens schwach bräunlich angefolgen. Schwarz sind ferner die äusserste Spitze des Abdomen, sowie die Scheide des Bohrers, letztere jedoch in der Mitte bräunlich, schwerzlich ist die Spitze der Tarsen sowie das Flügelgeäder. Augen hellbraun. Spitze der Mandibeln schwarz.

"Körperläne 6.5, Flügellänge 5, Bohrerlänge etwa 4.5 mm."

Translation:

"Three females from Mexico (v. Schlechtendahl).

"Appears to be closely related to *M. spermotrophus* but is distinguished from the latter by its considerable larger size among other things, and the median brownish color of the sheath of the ovipositor which is shorter than the body, etc.

"Color yellow; the following parts are black or dark brown: Ocellar area (both sides of the anterior ocellus appear surrounded by light color), sometimes two indefinite spots on the vertex, the scape appears to be blackish above (flagellum is broken off of all three specimens!), each side of the pronotum with a small longitudinal stripe, a narrow anterior marginal band on the mesonotum, the parapsidal furrows, an indefinite spot on the scapulae, the anterior margin of the axillae, an indefinite median longitudinal spot on the scutellum, the sides of the dorsulum, a basal band and similar narrower lateral and posterior marginal band on the metanotum, a larger dorsal spot on the first abdominal segment, the following dorsal segments are marked with indefinitely outlined brownish or blackish transverse areas, whereby undoubtedly the entire dorsum may appear blackish, with the exception of either the last or next to the last segment; the yellow parts of the abdomen seem to be covered with a weak brownish. In addition, the extreme tip of the abdomen is black as well as the sheath of the ovipositor, latter however brownish medially, the tip of the tarsus is blackish as well as the wing venation. Eyes light brown. Tip of mandible black.

"Body length 6.5, wing length 5, ovipositor length about 4.5 mm."

Type.—The type is probably either in the Zoologische Museum, Berlin, or in the Deutsche Entomologische Institut, Berlin Dahlem. Type not examined.

Type Locality.—Mexico.

Host.—*Unknown* (Likely a species of *Pseudotsuga*).

Comments—This species is known to the writer by description only. It is probable that further collecting and rearing will demonstrate that it is the

extreme dark female form of *spermotrophus* var. *nigrodorsatus*, new variety described in this paper.

EXCLUDED SPECIES*

The writer is indebted to Mr. A. B. Gahan for his assistance and opinions rendered in connection with the identity and synonymy of the following species.

(Pteromalidae)

Megastigma canadensis Ashmead, Trans. Amer. Ent. Soc., vol. 14, p. 186, 1887 (♂ only).

Megastigmus canadensis Ashm., Dalla Torre, Cat. Hymen., vol. 5, p. 286, 1898: Ashmead, in Smith, N. J. State Bd. Agr., 27th Rept., suppl., p. 553, (1899) 1900: *Schmiedeknecht*, Gen. Insect., fasc. 97, p. 119, 1909: Viereck, Conn. Geol. & Nat. Hist. Surv. Bul. 22, p. 513, 1916: Laidlaw, Scot. For. Jour., vol. 45, p. 191, 1931.

Comment—The type is a male pteromalid as Crosby (1913, p. 168) had correctly stated.

CALLIMOME PSYLLAE (Bridwell)

Megastigmus psyllae Bridwell, Proc. Kans. Acad. Sci., vol. 26, p. 205, 1899 (Nom. nud.).

Comments—There are two females in the collection of the U. S. National Museum under the name *psyllae*, MS name of Ashmead; one, the type, is headless. These specimens appear to be very close to *Callimome scalaris* Huber.

CERAMBYCOBIUS (?) FICIGERAE (Ashmead)

Megastigma ficigeras Ashmead, Trans. Amer. Ent. Soc., vol. 14, p. 185, 1887 (♂ only).
Megastigmus ficigerae Ashm., Dalla Torre, Cat. Hymen., vol. 5, p. 287, 1898: Schmiedeknecht, Gen. Insect., fasc. 97, p. 119, 1909: Laidlaw, Scot. For. Jour., vol. 45, p. 191, 1931.

Comments—Two male cotypes ("E. Fla.") are in existence, corresponding with Ashmead's statement, "Described from one specimen bred in 1885 from cynipidous galls *Holocaspis ficigera* Ashm., and another from *Amphibolips femorata* Ashm., MS. in 1886"; one of these is in the collection of the U. S. National Museum and the other, as noted by Crosby (1913, p. 168), is in the collection of the Academy of Natural Sciences, Philadelphia. According to Mr. Gahan, the specimen in the U. S. National Museum is a male eupelmid that may possibly represent the opposite sex of *Cerambycobius quercus* (Ashm.), described in 1886 from the same general locality (Trans. Amer. Ent. Soc., 13: 130) and later recorded from the gall of *Holocaspis ficigera* in Florida (Trans. Amer. Ent. Soc., 14: 190). The specimen in the Academy of Natural Sciences appears to be identical with that in the U. S. National Museum.

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* In addition to these species of North and Central America, it is to be noted that a Chilean species, *porteri*, described by Brethes (1916, p. 9) was later transferred by the same author (1920) to the genus *Perissocentrus* (Callimomidae: Monodontomerinae).

DIMEROMICRUS CECIDOMYIAE (Ashmead)

Megastigma cecidomyiae Ashmead, Trans. Amer. Ent. Soc., vol. 14, p. 185, 1887 (♂, ♀).

Megastigmus cecidomyiae Ashm., Dalla Torre, Cat. Hymen., vol. 5, p. 286, 1898: Schmiedeknecht, Gen. Insect., fasc. 97, p. 119, 1909: Laidlaw, Scot. For. Jour., vol. 45, p. 191, 1931.

Lochites auriceps Ashmead, Jour. Linn. Soc. Lond., vol. 25, p. 153, 1894: Mem. Carn. Mus., vol. 1, p. 397, 1904. New synonymy.

Megastigmus fulvus Cameron, Invert. Pacific., vol. 1, p. 58, 1904: Schmiedeknecht, Gen. Insect., fasc. 97, p. 119, 1909. New synonymy.

Lochites cecidomyiae (Ashm.) Crosby, Ann. Ent. Soc. Amer., vol. 6, p. 168, 1913.

Rileya cecidomyiae (Ashm.) Viereck, Conn. Geol. & Nat. Hist. Surv. Bul. 22, p. 520, 1916.

Comments—The types of this species are in the collection of the U. S. National Museum. Also, a portion of the cotypic material of Ashmead's *L. auriceps* from St. Vincent, West Indies is in the same institution. It is the opinion of Mr. Gahan that these type series are conspecific. *Cecidomyiae* was described seven years earlier than *auriceps* from a cecidomyiid gall on the composite, *Baccharia halmifolia*, from Florida.

The type of *Megastigmus fulvus* Cam. is probably in the British Museum (N. H.) However, two females of the original series, acquired by Cornell University from the C. F. Baker Collection, have been examined. These specimens bear the following data: "San Marcos, Nicaragua, Coll. Bakr," which corresponds with the type locality; and in addition, one has a plain white label with "*Megastigmus fulvus* Cam., n. sp.," apparently in Cameron's handwriting (Cornell U., Lot 546, Sub. 1082, Baker Coll.). There is little doubt that these are anything but a part of the material returned by Cameron to the Baker Collection; they agree perfectly with the original description, and in all essential details with the descriptions and type material of Ashmead's *cecidomyiae* and *auriceps*.

TENTATIVE SYNOPSIS OF THE NEARCTIC SPECIES BY GROUPS

I PHYSOCARPI GROUP
M. physocarpi Crosby .....p. 272
M. gahani, n. sp. .....p. 275

II BREVICAUDIS GROUP
M. brevicaudis Ratzeburg, p. 278
M. amelanchieris Cushman .....p. 282
M. americanus, n. sp. .....p. 285

III ACULEATUS GROUP
M. aculeatus (Swederus) p. 289
M. aculeatus var. *nigroflavus* Hoffmeyer .. p. 293
M. nigrovariegatus Ashmead .....p. 294

IV LARICIS GROUP
M. laricis Marcovitch .....p. 299
M. melanus, n. sp. .....p. 302

V STROBILOBIUS GROUP
M. piceae Rohwer .....p. 303
M. piceae var. *montana*, n. var. .....p. 305
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VI SPERMOTROPHUS GROUP
M. tsugae Crosby .....p. 308
M. tsugae var. *heterophyllae*, n. var. ....p. 309
M. hoffmeyeri Walley .....p. 311
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VII PINUS GROUP
M. pinus Parfitt .....p. 318
M. milleri, n. sp. .....p. 323

M. lasiocarpae Crosby .....p. 326
M. specularis Walley .....p. 328
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VIII ALBIFRONS GROUP
M. albifrons Walker .....p. 336
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IX PISTACIAE GROUP
M. floridanus, n. sp. .....p. 342

UNRECOGNIZED

M. variegatus Strand .....p. 344
M. falvipes Ashmead .....p. 343
M. pinus var. *marginatus* Hoffmeyer, ..p. 344

CATALOG OF THE SPECIES OF THE SUBFAMILY MEGASTIGMINAE

An attempt has been made to include all proposed names to 1940. Invalid specific and rejected varietal names, together with their original citations, are enclosed in parentheses, and known synonymy is indicated. Genera and species are arranged alphabetically and valid specific names are numbered separately under each genus.

BOOTANELLEUS Girault

Men. Queensl. Mus., 4: 308, 1915. *Monobasic*

1. *viridiscutellum* Girault, Mem. Queensl. Mus., 4: 308, 1915. Australia: Queensland.

BOOTANIA Dalla Torre

Wien. ent. Ztg., 16: 86, 1897. *Monobasic*
(Syn.: *Metamorpha* Walker, Trans. Ent. Soc. Lond., 1 (s. 3): 346, 1862. Name preocc.)

1. *leucospoides* (Walker), Trans. Ent. Soc. Lond., 1 (s. 3): 347, 1862. (*Metamorpha*). Asia: Bootan (or Bhutan). India: Assam.
(*leucaspidioidea* Dalla Torre, Cat. Hymen., 5: 315, 1898) = Emend.*

BOOTANOMYIA Girault

Mem. Queensl. Mus., 4: 297, 304, 1915
Genotype: *B. smaragdus* Girault. Orig. desig.

1. *aerea* Girault, Mem. Queensl. Mus., 4: 305, 1915. Australia: Queensland.
2. *ashmeadi* Girault, Mem. Queensl. Mus., 4: 305, 1915. Australia: Queensland.
3. *gemma* Girault, Phil. Jour. Sci., 36: 450, 1928. Philippine Islands: Luzon.
4. *longifasciatus* Girault, Mem. Queensl. Mus., 4: 305, 1915. Australia: Queensland.
5. *pax* Girault, Mem. Queensl. Mus., 4: 304: 1915. Australia: Queensland.
6. *pergratus* Girault, Mem. Queensl. Mus., 4: 304, 1915, Australia: Queensland.
7. *sanguiniventris* Girault, Mem. Queensl. Mus., 4: 306, 1915. Australia: Northern Territory.
8. *smaragdus* Girault, Mem. Queensl. Mus., 4: 304, 1915. Australia: Queensland.
9. *victoriae* Girault, Vict. Nat., 43: 262, 1928. Australia: Victoria.
10. *viridiscutellum* Girault, Mem. Queensl. Mus., 4: 304, 1915. Australia: Queensland.

NOTE: The description of *Bootanomyia unistriata*, which was published apparently by Girault, has not been seen.

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* The change in spelling first appeared in the Zoological Record, vol. 11, p. 362, (1864) 1876, and was later credited to Westwood (Thesaur. Ent. Oxon., p. 136, 1874) by Dalla Torre (1898, p. 315): this was not the case because Westwood adopted, though reluctantly, Walker's spelling of the name.

EPIBOOTANIA Girault

"New Hexapods." Priv. publ., 3 unnumbered pages, 1937.*
Genotype: *E. guttatipennis* Girault. Orig desig.

1. *guttatipennis* Girault, [New Hexapods], Priv. publ., 3 unnumbered pages, 1937, Australia.

(*nonvitta* Noble, Agr. Gaz. N. S. Wales, 44: 465, 1933: Dept. Agr. N. S. Wales, Sci. Bul. 53, pp. 38-40, 1936) = Nom. nud.

2. *nonvitta* Girault, Rev. Ent., 8: 81, 1938. Australia: N. S. Wales.
Host: *Eurytoma fellis* Gir. (Hymen.: Chalcidoidea; Eurytomidae).

3. *nympha* Girault, [New Hexapods], Priv. publ., 3 unnumbered pages, 1937. Australia.
"From *Microcitrus*" [wild lemon].

MEGASTIGMUS Dalman

Kongl. Vet. Acad. Handl., p. 178, 1820
Genotype: *M. bipunctatus* (Swederus). Desig. Crosby (1913)

(*abietis* Seitner, Centralbl. f. d. ges. Forstw., 42: 309, 1916) = *strobilobius* Ratz.

1. *acaciae* Noble, Proc. Linn. Soc. N. S. Wales, 64: 266, 1939. Australia: N. S. Wales.
Host: *Teperella trilineata* Cam. (Hymen.: Chalcidoidea; Perilampidae).

2. *aculeatus* (Swederus), Kongl. Vet. Acad. Handl., 16: 221, 1795, (*Pteromalus*).
Africa, Asia, Europe, North America. Ex seeds of *Rosa* spp.

aculeatus var. *nigroflavus* Hoffmeyer, Ent. Meddel., 16: 324, 1929. Japan, Russia, United States.
Ex seeds of *Rosa multiflora* Thunb., *R. gallica* L. and *Rosa* sp.

(*aculeatus* var. *flavus* Först., Dalla Torre, Cat. Hymen., 5: 285, 1898).

3. *adelaidensis* Girault, Mem. Queensl. Mus., 4: 301, 1915. South Australia.
Reared from an unidentified gall-maker.

4. *albifrons* Walker, Trans. Ent. Soc. Lond.., p. 314, 1869. United States: California and Arizona.
Ex seeds of *Pinus ponderosa* Laws.

5. *amamoori* Girault, [New Queensland insects captured without any reference to use], Priv. publ., 2 unnumbered pages, 1925. Australia: Queensland.

6. *amelanchieris* Cushman, Proc. Ent. Soc. Wash., 19: 81, (1917) 1918. United States.
Ex seeds of *Amelanchier* spp, and *Sorbus* sp.

7. *americanus* Milliron. United States.
Ex seeds of *Sorbus* sp.

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* There appears never to have been a description of the genus *Epibootania*. In two publications prior to 1937, Noble (1933, 1936) therefore employed a generic name which really had no standing. In these two publications he also referred to a species "*nonvitta*" which was then undescribed, and credited it to Girault, who first described it under that name in *Epibootania* in 1938. The first attempt to validate *Epibootania* was made by Girault a year earlier in a privately mimeographed "publication" entitled in part, "New Hexapods." No generic characters were given and the species *guttatipennis* was designated as genotype with the words "jaws bidentate" in parentheses following the name. There is much doubt whether this mimeographed "publication" really constitutes a publication or not, but it is here accepted tentatively as such to avoid any possible confusion. If the paper in question is not accepted, *Epibootania* must be based on *nonvitta* and date from 1938,

8. *asteri* Ashmead, Proc. Linn. Soc. N. S. Wales, 25: 332 (1900) 1901. Australia: N. S. Wales.
Reared from dipterous gall on snowbush, *Aster ramulosus*.

9. *atedius* Walker, Ann. & Mag. Nat. Hist., 7(2): 214, 1851. Europe: Britannia.
(*ballestrerii* (Rondani), Bul. Soc. ent. ital., 9: 204, 1877. (*Trigocarpus*)) = *pistaciae* Walker. Southern Europe.

10. *banksiae* (Girault), Trans. Roy. Soc. S. Austr., 53: 341, 1929. (*Epimegastigmus*). South Australia.
Reared from unidentified galls on *Banksia*.

11. *bipunctatus* (Swederus), Kongl. Vet. Acad. Handl., 16: 205, 1795. (*Pteromalus*). Europe.
Ex seeds of *Juniperus*.
(*bohemanii* Ratzeburg, Ichneum. d. Forstinsect., 2: 182, 1848) = *dorsalis* (Fabr.).

12. *borriesi* Crosby, Ann. Ent. Soc. Amer., 6: 169, 1913. Japan.
Ex seeds of *Abies mariesii* Mast. and *A. sachalinensis* Mast.

13. *borus* Walker, Monogr. Chalcid., 2: 5, 1839. Australia: Tasmania.

14. *brachyscelidis* Ashmead, Proc. Linn. Soc. N. S. Wales, 25: 333, (1900) 1901. Australia: N. S. Wales.
Host: (*Brachyscelis crispa* Fuller) = *Apiomorpha strombylosa* (Tepp.).

15. *brachychitoni* Froggat, Agr. Gaz. N. S. Wales, 16: 233, 1905. Australia: N. S. Wales.
Reared from galls on kurrajong tree, *Brachychiton populneus*.

16. *brevicaudis* Ratzeburg, Ichneum. d. Forstinsect., 3: 225, 1852. Europe, United States (Minnesota).
Ex seeds of *Sorbus aucuparia* L., and *S. scandica* Fr. (= *S. intermedia* Pers.).

17. *brevivalvus* (Girault), [Characteristics of new Australian insetcs], Priv. publ., 2 unnumbered pages, 1926. (*Epimegastigmus*). Australia: Queensland, N. S. Wales.
Host: *Eurytoma fellis* Gir. (Hymen.: Chalcidoidea; Eurytomida).

18. *caperatus* Milliron. Canada: Ontario.

19. *cecili* Girault, Trans. Roy. Soc. S. Austr., 53: 339, 1929. South Australia.
(*collaris* Boheman, Kongl. Vet. Acad. Handl., p. 332, (1833) 1834) = *aculeatus* (Swed.).
(*collaris* var. *flavus* Forst., Mayr, Verh. k.-k. zool.-bot. Ges. Wien, 24: 138, 1874).

20. *cryptomeriae* Yano, Rep. For. Exp., Forestry Bur. [Tokyo], No. 17, pp. 36-58, 1918; Insect World [Gifu], 22: 373, 1918. Japan.
Ex seeds of *Cryptomeria japonica* Don. and *Chamaecyparis obtusa* Sieb. & Zucc.
(*cynorrhodi* Perris, Ann. Soc. ent. Fr., 6: 222, 1876) = *aculeatus* (Swed.).

21. *dorsalis* (Fabricius), Suppl. ent. system., p. 231, 1798 (*Ichneumon*). Europe.
Host: Cynipidae.

22. *drances* Walker, Monogr. Chalcid., 2: 5, 1839. Australia: Tasmania.
(*erythrothorax* (Nees), Hymen, Ichneum. affin. Monogr., 2: 65, 1834. (*Torymus*)) = *bipunctatus* (Swed.) ?

23. *eucalypti* Girault, Mem. Queensl. Mus., 4: 300, 1915. Australia: Victoria.
Reared from unidentified galls on *Eucalyptus*.

24. *fieldingi* Girault, Mem. Queensl. Mus., 4: 301, 1915. Australia: Queensland.
Reared from "miscellaneous" unidentified galls.

25. *flavipes* Ashmead (nec Ashmead, 1888), Trans. Amer. Ent. Soc., 13: 128, 1886. United States: Florida.

26. *flavivariegatus* Girault, Mem. Queensl. Mus., 4: 300, 1915. Australia: Queensland.

27. *floridanus* Milliron. United States: Florida.
(*flavus* Förster, Verh. naturh. Ver. preuss, Rheinl. u. Westph., 16: 109, 1859) = *aculeatus* (Swed.).

28. *formosus* Milliron. Canada: Ontario and Quebec.

29. *fulvipes* (Girault), Can. Ent., 45: 222, 1913. (*Xanthosomoides*). Australia: Queensland, South Australia.

30. *fuscicornis* Girault, Trans. & Proc. Roy. Soc. S. Austr., 37: 81, 1913. Australia. Tasmania.

31. *gahani* Milliron. United States.
Ex seeds of *Physocarpus opulifolius* var. *intermedius* (Rydb.) Robinson.
(*giganteus* Walker, Ann. & Mag. Nat. Hist., 9: 39, 1852) = *stigmatizans* (Fabr.).
(*giganteus* (Girault), Verh. VII Internat. Kongr. Ent., 1: 147-148, 1939. (*Epimegastrigmus* ?)) = Nom. nud.

32. *grotiusi* (Girault), Mem. Queensl. Mus., 4: 307, 1915. (*Epimegastigmus*). Australia: Northern Territory.

33. *herndoni* Girault, [Microhymenoptera Australiensis nova], Priv. publ., 3 unnumbered pages, 1935. Australia.

34. *hilaris* Girault, Trans. Roy. Soc. S. Austr., 53: 339, 1929. South Australia.

35. *hilli*, Dodd, Trans. & Proc. Roy. Soc. S. Austr., 41: 361, 1917. Australia.
Reared from a gall on *Eucalyptus miniatus*.

36. *hoffmeyeri* Walley, Can. Ent. 64: 189, 1932. Nom. nov. for *M. spermotrophus canadensis* Hoffmeyer, 1930. United States and Canada.
Ex seeds of *Tsuga canadensis* (L.) Carr.

37. *iamenus* Walker, Monogr. Chalcid., 2: 6, 1839. Australia: N. S. Wales.
Host: (*Brachyscelis pileata* Schrader) = *Apiomorpha pileata* (Schrad.); also reared from globular gall on *Eucalytpus*.

38. *immaculatus* Ashmead, Proc. U. S. Nat. Mus., 29: 401, 1905 (1906). Philippine Islands: Luzon.

39. *inamurae* Yano, Rep. For. Exp., Forestry Bur. [Tokyo], No. 17, pp. 38-58, 1918; Insect World [Gifu], 22: 374, 1918. Japan.
Ex seeds of *Larix leptolepis* Murray.

40. *japonicus* Ashmead, Jour. N. Y. Ent. Soc., 12: 146, 1904. Japan.

41. *koebelei* Ashmead, Jour. N. Y. Ent. Soc., 12: 146, 1904. Japan: Atami.

42. *laricis* Marcovitch, Can. Ent., 46: 435, 1914. United States: New York.
Ex seeds of *Larix laricina* (Du Roi) Koch.

43. *lasiocarpae* Crosby, Ann. Ent. Soc. Amer., 6: 163, 1913. Western United States, Southwestern Canada.
Ex seeds of *Abies lasiocarpae* (Hook.) Nutt., and *L. amebilis* (Dougl.) Forbes.

44. *leeuweni* Ferriere, Ann. Soc. ent. Fr., 98: 144, 1929. Java.
Ex fruit of *Milletia sericea*.

45. *limoni* (Girault), [New pests from Australia. II], Priv. Publ., 3 unnumbered pages, 1926. (*Epimegastigmus*). Australia: Queensland.
"From native limes."

46. *longicauda* Girault, Trans. & Proc. Roy. Soc. S. Austr., 37: 81, 1913. South Australia.

47. *maculatipennis* (Girault), Can. Ent. 45: 221, 1913. (*Xanthosomoides*). Australia: N. S. Wales, Queensland, South Australia.
Reared from unidentified gall; also "from Port Jackson figs."

48. *melanus* Milliron. United States: Michigan.

49. *melleus* Girault, Mem. Queensl. Mus., 4: 301, 1915. Australia: Queensland.

50. *mendocinus* Kieffer & Jörgensen, Centralbl. Bakt. (Abt. 2), 27: 410, 1910. South America: Argentina.
Reared from a cecidomyiid gall, *Oligotrophus* (?) *lyciicola* Kieff. & Jörg.
(*microphilus* Dalla Torre, Cat. Hymen., 5: 287, 1898) = Emend.
(*microspilus* Thomson, Hymen. Scand., 4(1): 62, 1875 = *bipunctatus* (Swed.), teste Hoffmeyer (1931, p. 266).

51. *milleri* Milliron. Western North America.
Ex seeds of *Abies* spp.

52. *nigrovariegatus* Ashmead, Colo. Biol. Ass'n., Bul. 1, p. 26, 1890. North America.
Ex seeds of *Rosa* spp.

53. *nigropropodeum* Girault, [Miridae et Hymenoptera nova Australiensis], Priv. publ., 3 unnumbered pages, 1934. Australia.

54. *pallidiocellus* Girault, Trans. Roy. Soc. S. Austr., 53: 339, 1929. Australia: Queensland, South Australia.

55. *pascali* (Girault), [Some beauties . . . notably new insects], Priv. publ., 5 unnumbered pages, 1933. (*Epimegastrigmus*). Australia.

56. *pergracilis* Girault, Mem. Queensl. Mus., 4: 301, 1915. Australia: Queensland.

57. *physocarpi* Crosby, Ann. Ent. Soc. Amer., 6: 158, 1913. United States and Canada.
Ex seeds of *Physocarpus opulifolius* (L.) Maxim.

58. *piceae* Rohwer, Can. Ent., 47: 97, 1915. Western United States.
Ex seeds of *Picea* spp.

picea var. *montana* Milliron. United States: Montana.
Ex seeds of *Picea Engelmannii* (Parry) Engelm.

(*piceae* Seitner, Centralbl. f. d. ges. Forstw., 42: 315, 1916) = *suspectus* Borr.

59. *pictus* (Förster), Beitr. Monogr. Pteromal., p. 31, 1841. (*Torymus*). Europe: Germany.
Ex seeds of *Rosa* spp.

60. *pinus* Parfitt, Zool., 15: 5629, 1857. Western United States and Scotland.
Ex seeds of *Abies* spp.

pinus var. *marginatus* Hoffmeyer, Ent. Meddel., 17: 216, 1930. United States: Oregon.
Ex seeds of *Abies grandis* Lindl.

(*pinus* var. *crosbyi* Hoffmeyer, Ent. Meddel., 17: 215, 1930.)

61. *pistaciae* Walker, Notes on Chalcid., Pt. 2, p. 35, 1871. Southern Europe.
Ex seeds of *Pistacia* spp.

(*punctum* (Förster), Beitr. Monogr. Pteromal., p. 31, 1841. (*Torymus*)) = *aculeatus* (Swed.).

62. *quadrifasciativentris* Girault, Mem. Queensl., Mus. 4: 302, 1915. Australia: Queensland.

63. *quadrisetae* Girault, Rec. S. Austr. Mus., 3: 330, 1927. Australia: Tasmania.

64. *quinquefasciatus* (Girault), Mem. Queensl. Mus., 4: 308, 1915. (*Epimegastigmus*). Australia: Queensland.

65. *quinquesetae* (Girault), [New Capsidae and Hymenoptera], Priv. publ., 4 unnumbered pages, 1934. (*Epimegastigmus*). Australia.
Reared from flower galls on *Eucalyptus macrorrhyncha* F. v. M. competitor of *Fergusonina* flies in such galls (Currie, 1937).

66. *rafni* Hoffmeyer, Ent. Meddel., 16: 331, 1929. Western United States and Southwestern Canada.
Ex seeds of *Abies* spp.

67. *seitneri* Hoffmeyer, Ent. Meddel., 16: 327, 1929. Europe: Denmark; Finland.
Ex seeds of *Larix decidua* Mill.

68. *sexsetae* Girault, Rec. S. Austr. Mus., 3: 331, 1927. Australia: Tasmania.

69. *speciosus* Girault, Mem. Queensl. Mus., 4: 300, 1915. Australia: Queensland.

70. *specularis* Walley, Can. Ent., 64: 187, 1932. Northeastern United States and Eastern Canada.
Ex seeds of *Abies balsamea* (L.) Mill.

71. *spermotrophus* Wachtl, Wien. ent. Ztg., 12: 1893; Centralbl. f. d. ges. Foretw., 19: 8, 1893. New Zealand, Western United States, Great Britain, Western Europe.

Ex seeds of *Pseudotsuga taxifolia* (Lam.) Britt.

spermotrophus var. *nigrodorsatus* Milliron. United States: California.
Ex seeds of *Pseudotsuga macrocarpa* (Torr.) Mayr.

(*spermotrophus* var. *canadensis* Hoffmeyer, Ent. Meddel., 17: 218, 1930 (nec *M. canadensis* Ashmead, 1887)) = *hoffmeyeri* Wall.

(*spermotrophus* var. *hoffmeyeri* Walley, Can. Ent., 64: 188, 1932) = *hoffmeyeri* Wall.

(*stigma* (Fabricius), Syst. Piez., p. 155, 1804. (*Cleptes*)) = *stigmatizans* (Fabr.).

72. *stigmatizans* (Fabricius), Suppl. ent. system., p. 230, 1798. (*Ichneumon*). Europe.
Host: Cynipidae.

73. *strobilobius* Ratzeburg, Ichneum. d. Forstinsect., 2: 182, 1848. Europe.
Ex seeds of *Picea excelsa* Link.

74. *sulcicollis* Cameron, Proc. Linn. Soc. N. S. Wales, 36: 644, 1911. Australia: N. S. Wales.
"Associated with galls on kurrajong" (Girault, 1915b, p. 299).

sulcicollis var. *walsinghami* Girault, Roy. Soc. S. Austr., 53: 340, 1929. South Australia.

75. *suspectus* Borries, Tidskr. f. Skovvaeson, 7(B): 29, 1895. Europe.
Ex seeds of *Abies* spp.

suspectus var. *pinsapinis* Hoffmeyer, Ent. Meddel., 17: 264, 1931. Europe and North Africa.
Ex seeds of *Abies pinsapo* Boiss. and *Cedrus* sp. (probably *atlantica*).

76. *synophri* Mayr, Verh. k.-k. zool.-bot. Ges. Wien, 24: 129, 1874. Europe: Austria.
Host: Cynipidae.

77. *tasmaniensis* Girault, Trans. & Proc. Roy. Soc. S. Austr., 37: 80, 1913. Australia: Tasmania.
"Reared from larvae of flies attacking *Helichrysum scorpioides.*"

78. *thuyopsis* Yano, Rep. For. Exp., Forestry Bur. [Tokyo], No. 17, pp. 38-58, 1918; Insect World [Gifu], 22: 374, 1918. Japan.
Ex seeds of *Thujopsis dodobrata* Sieb. & Zucc.

79. *titanus* (Girault), Verh. VII Internat. Kongr. Ent., 1: 148, 1939. (*Epimegastigmus*). New Guinea: Papua.

80. *tostini* Girault, [Miridae et Hymenoptera nova Australiensis], Priv. publ., 3 unnumbered pages, 1934. Australia.
(*transversus* Walker, Ent. Mag., 1: 117, 1833) = *aculeatus* (Swed.).

81. *trisulcatus* (Girault), Mem. Queensl. Mus., 4: 308, 1915. (*Epimegastigmus*). Australia: Queensland.
Reared from unidentified gall.

(*trisulcus* (Noble), Agr. Gaz. N. S. Wales, 44: 465, 1933. (*Epimegastigmus*)) = Nom. nud.

82. *trisulcus* (Girault), [Miridae et Hymenoptera nova Australiensis], Priv. publ., 3 unnumbered pages, 1934. (*Epimegastigmus*). Australia: N. S. Wales.
Host: *Eurytoma fellis* Gir. (Hymen.: Chalcidoidea; Eurytomidae).

83. *tsugae* Crosby, Ann. Ent. Soc. Amer., 6: 162, 1913. Northwestern United States.
Ex seeds of *Tsuga mertensiana* (Bong.) Sarg.

tsugae var. *heterophyllae* Milliron. Southwestern Canada.
Ex seeds of *Tsuga heterophylla* (Raf.) Sarg.

84. *variegatus* Strand, Wien. ent. Ztg., 30: 93, 1911. Mexico.
(*vexillum* Ratzeburg, Ichneum. d. Forstinsect., 2: 182, 1848) = *aculeatus* (Swed.).

85. *voltairei* (Girault), [New Queensland Insecta captured without any reference to use], Priv. Publ., 2 unnumbered pages, 1925. (*Epimegastigmus*) Australia.

86. *wachtli* Seitner, Centralbl. f. d. ges. Forstw., 42: 320, 1916. South Central Europe.

Ex seeds of *Cupressus sempervirens* L.

(*xanthopygus* Förster, Verh. naturh. Ver. preusse. u. Westph., 14: 110, 1859) = *dorsalis* (Fabr.).

NOTE: Attempts to locate the original descriptions of the following species of *Megastigmus*, all apparently described by Girault, have been unsuccessful: *Megastigmus spenseri*, *Epimegastigmus bisulcus* and *E. bucklei*.

NEOMEGASTIGMUS Girault

Can. Ent., 47: 47, 1915*; Mem. Queensl. Mus., 4: 294, 1915

Genotype: *N. lividus* Girault
Desig. by Girault, Mem. Queensl. Mus., 4: 294, 1915

1. *ater* Girault, Rec. S. Aust. Mus., 3: 331, 1927. South Australia.
   "From galls on leaves of *Eucalyptus obliqua*."
2. *auritibiae* Girault, Mem. Queensl. Mus., 4: 297, 1915. Australia: Queensland.
3. *collaris* Girault, Can. Ent., 47: 47, 1915; Mem. Queensl. Mus., 4: 295, 1915. Australia.
4. *filius* Girault, Mem. Queensl. Mus., 4: 295, 1915. Australia: Queensland.
5. *hyalinus* Girault, Mem. Queensl. Mus., 4: 296, 1915. Australia: N. S. Wales.
6. *leai* Girault, Trans. Roy. Soc. S. Austr., 53: 341, 1929. Australia.
   (*lividus* Girault, Can. Ent., 47: 47, 1915) = Nom. nud.
7. *lividus* Girault, Mem. Queensl. Mus., 4: 294, 1915. Australia: Queensland.
   "Associated with cecidomyiid gall on *Careya australis*."
   lividus var. *badius* Girault, Mem. Queensl. Mus., 4: 297, 1915. Australia: Queensland.
8. *petiolatus* Girault, Can. Ent., 47: 47, 1915; Mem. Queensl. Mus., 4: 295, 1915. Australia: Queensland.
9. *rufithorax* Girault, Mem. Queensl. Mus., 4: 296, 1915. Australia: N. S. Wales.
   rufithorax var. *nelsonensis* Girault, Mem. Queensl. Mus., 4: 296, 1915. Australia: Queensland.
10. *saltensis* Girault, Mem. Queensl. Mus., 4: 295, 1915. Australia: Queensland.
11. *varius* Girault, Mem. Queensl. Mus., 4: 296, 1915. Australia: Queensland.

NOTE.—The original description of *Neomegastigmus poeta*, which appears to be one of Girault's species, could not be located.

ODOPOIA Walker

Notes on Chalcid., Pt. 2, p. 36, 1871. *Monobasic*
Syn.: *Odopoea* Dalla Torre, Cat. Hymen., 5: 315, 1898. Emend.)

1. *atra* Walker, Notes on Chalcid., Pt. 2, p. 36, 1871. India: Ceylon.

PARAMEGASTIGMUS Girault

Mem. Queensl. Mus., 4: 297, 306, 1915
Genotype: *P. flavus* (Girault). Orig. desig.

1. *flavus* (Girault), Ent. News, 25: 25, 1914. (*Spilomegastigmus*). Australia: Queensland.

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* Gahan and Fagan (1923) have cited this as the publication in which the genus was established, evidently because of the inclusion of two (valid) new species. The original description of *Neomegastigmus* and the selection of a genotype were not made, however, until four months later in the Memoirs of the Queensland Museum as cited above.

2. *immaculaticorpus* Girault, Mem. Queensl. Mus., 4: 307, 1915. Australia: Queensland.

SPILOMEGASTIGMUS Cameron

Spolia Zeyl., 3: 73, 1905. *Monobasic.*

1. *ruficeps* Cameron, Spolia Zeyl., 3: 74, pl. A, fig. 3, 1905. India: Ceylon.

Part II.—Biological Studies in the Genus Megastigmus

HISTORICAL-BIOLOGICAL INTRODUCTION

One of the most interesting and intriguing chapters that can be written about the biology of the Chalcidoidea is that which concerns *Megastigmus*. Apparently, nothing of biological interest appeared before the short paper by Walker (1845) which mentioned the rearing of *M. dorsalis* (Fabr.) from the cynipid gall, "*Teras terminalis* Hartig." In the following year, Walker (1846a) again was concerned with this species and gave a detailed monthly account of the numbers of specimens reared in 1845 and 1846 from the same species of gall. To Dufour (1847) probably should go the credit for being the first to emphasize the entomophagous habit of *Megastigmus*. He reared *M. stigmatizans* (Fabr.) from the gall of "*Diplolepis reaumurii*" on which he clearly stated it was a parasite. Interestingly, he made the following remark in his discussion: ". . . il est appelé à contre-balancer, à réduire la trop grande multiplication du Diplolepe, à en devenir le correctif, peute-être, qui le sait! . . ."

Evidence to support the fact that certain species reared from cynipid galls were true parasites began to accumulate gradually. But, by direct influence of the general conception that no chalcid was phytophagous, true seed infesting species were soon involved as being insect parasites. The attribution of entomophagous habits to phytophagous species of *Megastigmus* first occurred, apparently, in parts of one of the important works of Ratzeburg (1848, 1852). For instance, he stated (1848) that *M. strobilobius* Ratz. lived in spruce cones probably on *Tortrix strobiliana* (=*Laspeyresia*), and that *M. vexillum* Ratz. (=*aculeatus* (Swed.)) was reared by Bouché from *Trypeta continua* Meig. (=*Spilographa alternata* Fall.) infesting rose hips. In a later volume (1852), he left no doubt about the parasitic nature of these species and listed them as such without query. This was followed by the work of Reinhard (1857), who accepted Ratzeburg's opinion regarding *aculeatus*, but made the important observation that the *Megastigmus* remained over winter in the fruits, while the fly deserted and entered the ground in the autumn. He had also noted the females of *Megastigmus* ovipositing in the rose fruit. In the same year, Parfitt (1857a) described a new species, which he named *pinus*, from the cones of various California conifers and, although the species was later proved to be phytophagous, at that time he considered it to be parasitic on a cynipid.

Mayr's (1874) extensive treatment of the European Torymidae (=Callimomidae) summarized what was then known concerning the hosts and habits of the European species of *Megastigmus*. Of the six which were included in that work, *M. dorsalis* (Fabr.), *M. stigmatizans* (Fabr.) and *M. synophri* Mayr were the established gall infesting, parasitic species; *M. collaris* Boh.

(=*aculeatus* (Swed.)) was cited as being a parasite on the authority of Ratzeburg; *M. strobilobius* Ratz. (erroneously synonymized under *M. pictus* (Forst.)) was regarded likewise on the same authority; and Mayr himself first made use of lepidopterous host data for *M. bipunctatus* (Swed.) in published form. Thus, all of the megastigmine species known to that author undoubtedly were considered to be entomophagous. His own observations on the gall infesting forms, as well as the nature of host information available in previous literature or on labels, supported such a conclusion. By virtue of the fact that his contribution was at that time such an important one, it naturally exerted a strong influence favorable to the general belief that all species of *Megastigmus* were parasites of other insects.

Perris (1876) published his results of four years' work on *M. cynorrhodi* Perr. (=*aculeatus* (Swed.)) which included several valuable observations. He could find no evidence of host insects in the intact pulp of infested rose hips. Moreover, he found the exit holes by way of which adults emerged from within the seeds. That this species was most likely phytophagous was the conclusion at which he arrived. His intention to continue his investigations may have been carried out, but nothing more on the subject was ever published by him.

A year later, in Italy, Rondani (1877) was confronted with a species of *Megastigmus* which he named *ballestrerii* (=*pistaciae* Walk.). For several years prior to this time it had been supposed that Coleoptera inhabiting the fruit of *Pistacia vera* served as hosts of this insect, but Rondani finally and definitely concluded in a note, which has been generally overlooked, that the species was phytophagous and that it consumed nothing but the seeds of *P. vera*. Again in 1878 he detailed substantially the same conclusion. Naturally, at that time the association of a phytophagous habit with a member of the "Torymidae" was an "extraordinary exception to the general rule." Unfortunately, his notes on the habits of this species are brief and do not reveal details of the observations stated to have been made, but we may regard Rondani as being one of the earliest workers to conclude that a species of *Megastigmus* was strictly phytophagous.

The first indisputed evidence that constituted the answer to the question of whether or not certain species were strictly phytophagous was presented in the careful work of Wachtl (1884a, b). After making critical observations on *M. collaris* Boh. (=*aculeatus*) and *M. pictus* (Först.) he emphasized that neither of these species was entomophagous, but that both were true plant feeders.

The common belief that all chalcids, save for *Isosoma* (=*Harmolita*) and *isosoma*-like forms, were parasitic on other insects persisted in spite of the convincing evidence showing that exceptions did occur. This view was strongly emphasized by Howard (1892) who declined to accept Wachtl's claim. The close of the nineteenth century and the beginning of the twentieth constituted the period of strenuous controversy over the question of phytophagy in *Megastigmus*. Again Wachtl (1893a, b) added to our knowledge and substantiated his former claim when he described *M. spermotrophus* as a new phytophagous species destroying the seeds of Douglas fir; this species has since attracted attention as a pest in plantations of Douglas fir in Europe.

Riley (1893) summarized much of the information on *Megastigmus*, paying especial attention to the phytophagous habit and brought forward more convincing evidence obtained in a letter from Mr. Herman Borries, who had made careful observations on a species destroying the seeds of fir (*Abies pectinata* DC.) in Denmark as early as 1887. Judeich and Nitsche (1893, 1895), through their own investigations, assisted in establishing the fact that certain species were pests of conifers, in direct opposition to the older school.

At this time, Borries (1895) himself published a paper that was generally overlooked until Hoffmeyer (1929) called it to our attention; it contains the observations to which Riley had previously referred. He discussed his early work in Denmark with the fir seed infesting species which he described as new. He also referred briefly to a number of other species reared chiefly from imported North American coniferous seeds. From the early work of Borries, and from the interesting material he published, we are sure he appreciated the destructive nature of certain species. Yet, his view regarding the habits of *Megastigmus* was one open to question. He pointed out the opinions of Wachtl and Nitsche supporting phytophagy, but at the same time reminded us that parasitic larvae are known to supplement their animal food with plant material; this he himself had experienced with torymid (callimomid) larvae. Thus, it seems apparent that Borries entertained the opinion that certain reputed phytophagous species might be true parasites during their initial stages and later revert to phytophagy, becoming in this way the destructive pests of the seeds, though, by no means was he sure that such was the case in *Megastigmus*.

As far as we can ascertain, our native *M. spermotrophus* Wachtl was introduced into Scotland either during the eighteen nineties or the very early years of the twentieth century. It was recognized there as a serious pest in 1905 and 1906. Consequently, MacDougall (1906a *et seq.*) conducted studies on its life history, and could reach no other conclusion than that which confirmed the earlier view of Wachtl. Gradually more and more evidence has accumulated that definitely established beyond doubt that certain species, long held in question or regarded as insect parasites, are truly phytophagous.

Among the more recent important contributions adding to our biological knowledge of the phytophagous species we may cite those of Rodzianko (1908a, b), Crosby (1909, 1913), Rohwer (1913), Seitner (1916), De Stefani (1908 *et seq.*), Yano and Koyama (1918a, b), Gahan (1922), Laidlaw (1931), Oudemans (J. T., 1933), and Escherich (1938).

Certain of the European species, i.e., *M. dorsalis* (Fabr.), *M. stigmatizans* (Fabr.), and *M. synophri* Mayr, long have been regarded as entomophagous species. In recent years, the most enlightening and indisputable evidence for true insect parasitism in *Megastigmus* is to be found among some of the Australian species. Noble (1933-1940), working with several of these species, has made valuable biological contributions, particularly in his more recent publications.

BIOLOGY OF MEGASTIGMUS

The fact that some species of *Megastigmus* are phytophagous and others are entomophagous partly accounts for the difficulty encountered by earlier

workers in attempting to interpret their biologies and ascertain true hosts. Moreover, most species occur along with other kinds of insects known to infest or inhabit the same fruit or gall. Consequently, when this second insect was reared from fruits from which a species of *Megastigmus* also emerged, it naturally led to the assumption that a parasitic relationship existed. For example, the common European trypetid fly, which occurs in rose hips, was once believed to be the host of *M. aculeatus* (Swed.), apparently because it inhabited the same kind of fruit, or because the supposed host and the megastigmine both were reared from the same. It is unnecessary here to enumerate other parallel examples that could be cited. Misidentifications also have been responsible for some of the erroneous host records that have appeared. Disconcerting it is, that the literature on *Megastigmus* species from about 1846 to the present contains a considerable list of erroneous or doubtful insect and plant hosts, especially with respect to the phytophagous species. Certain authors are prone to copy and promulgate in the more recent literature such older records of insect parasitism which are extremely doubtful, or which have been disproved long ago. It is not entirely out of place, therefore, to emphasize at this point the caution with which we ought to accept such data, and above all, to emphasize the necessity for more critical analysis of these dubious records.

Before presenting a brief general discussion of the biology of the genus, the writer proposes to dismiss two species now being treated in the literature as parasites of lepidopterous insects. Mayr (1874) appears to have been the first to publish host data for the European *M. bipunctatus* (Swed.) as follows: Two males (Heyden), said to have been reared from *"Tinea epilobiella"* (*Laverna epilobiella* S.V., according to Mayr), now known commonly in European literature under the name *Anybia epilobiella* Röm.; one male, and one female (Förster), said to have been reared from *"Hypsolophus marginellus"* (=*Dichomeris marginella* (Fabr.)). It seems that the data originally attached to these four specimens have formed the only basis for treating the species as a parasite of lepidopterous insects. Naturally, the host data were copied by Dalla Torre (1898) whose work is very widely used. In referring to *M. bipunctatus,* neither Seitner (1916) nor Hoffmeyer (1931) has added any records of new or recent rearings. It now appears that all references to these reputed host species can be traced to their original source, even though some subsequent authors have merely given "Microlpidóptera," and since confirmation appears to be entirely lacking it seems that little emphasis should be placed on the data which have been taken from Mayr's work.

Complete doubt of an entomophagous habit in this instance results from a review of certain facts. *Anybia epilobiella* Röm. belongs to the family Cosmopterygidae (Momphidae auct.) and is a leaf miner attacking species of *Circaea* and *Epilobium,* and occasionally species of *Chamaemerium,* all oenotheraceous plants distantly removed from the established host of *Dichomeris marginella* (Fabr.), the second of the two supposed lepidopterous hosts of *M. bipunctatus. D. marginella,* of the Gelechiidae, is found both in Europe and in the United States, and here attacks *Juniperus communis* L. and is commonly referred to as the "juniper webworm." If *M. bipunctatus*

was truly parasitic on these, thereby indicating a wide host preference, is it not reasonable to assume that it should have been reared from other lepidopterous hosts? Moreover, it is not unreasonable to expect that a parasitic habit should have been verified by several different rearings, especially involving the hosts in question, during the time the species has been known and encountered.

The evidence at hand indicates that this species of *Megastigmus* is phytophagous in the seeds of conifers. Since *D. marginella* feeds on juniper, it is easy to understand how older records might have erroneously stated it to be the host, when in reality the specimens of *bipunctatus* probably came from the seeds of this plant. *Bipunctatus* is represented in the collection of the U. S. National Museum by nine specimens, all of which were reared from the seeds of *Juniperus* sp. as follows: 6 females, 2 males, Issyk, Kul, U.S.S.R.; 1 male, Austria. In addition to stating that the species was parasitic on Microlepidoptera, presumably based on the foregoing original records of Mayr, Hellén (1933) records it from the cones of spruce (rearing by Forsius); however, one must be mindful of a possible misidentification in this case before accepting such a record as being authentic for *bipunctatus*, as this species might be confounded easily with *M. strobilobius* Ratz. which infests the seeds of *Picea excelsa* Link. It thus appears that *bipunctatus* should not be known henceforth as an entomophagous species until authentic and indisputable records may be acquired to demonstrate that it is a parasite of other insects.

The second species under consideration is *M. brevicaudis* Ratz., a single specimen of which Franklin (1916) reported found along with specimens of *Syntomaspis* (=*Callimome*) in a can containing pupae of the cranberry fruitworm, *Mineola vacinii* (Rly.). Desiring to learn something about the technique that was employed in rearing and, if possible, to learn the whereabouts of this single specimen, correspondence with Dr. Franklin, East Wareham, Massachusetts, brought the following reply, dated October 4, 1940:

"Replying to yours of Sept. 30, I reared only one specimen of *Megastigmus* from the cranberry fruitworm. It is certainly a very rare parasite of that species. Mr. A. A. Girault, of the Bureau of Entomology (U. S. Department of Agriculture), made the determination for me and I think he retained the specimen. If he did retain it, I think it may be now in the collection of the National Museum. If he returned it to me, it certainly was burned in the fire which destroyed our building here in 1926.

"The specimen I reared emerged in a tight coffee can containing only fruitworm pupae in their cocoons and sand dug out carefully from the interior of a sand bank to guard against the presence of extraneous living forms. There may have been present also a few decayed cranberries from which the fruitworms emerged. I am sorry I do not now recall further details connected with this. I have not observed this parasite a second time."

The specimen in question appears to be nowhere among the megastigmine material in the U. S. National Museum, and failure to locate it therefore makes it impossible to check the original determination by Girault. Before formulating conclusions from this unique record, which is in direct conflict with all we now know about the species, there are two possibilities that should

be taken into consideration. First, a seed of the host plant of *M. brevicaudis* might have, in some manner, found its way into the can along with the sand or dried cranberries and was overlooked. Any extraneous material that might have yielded the specimen of *Megastigmus* would have been small, such as a seed of a mountain ash berry, because the very careful technique of Dr. Franklin eliminates such material of conspicuous size. Secondly, there is the possibility of a misidentification which does not seem very likely at present, at least the genus. According to the report, the specimen of *Megastigmus* and those of *Callimome* were obtained on July 2 and 3, 1907; if these represent dates of natural emergence, both would appear to be too late for *M. brevicaudis* in this latitude.

Granting that this species might possibly be a very rare parasite of the cranberry fruitworm, it would seem, indeed, to be a remote possibility because the species in both Europe and North America has been demonstrated, without question, to live as a true phytophagous species. Dr. Franklin has been concerned with pests of cranberries for many years and he had obtained but a single specimen. It is very doubtful if *M. brevicaudis* will be found capable, even in rare instances, of exhibiting a complete entomophagous existence that must of necessity be construed if this record is accepted. It appears, therefore, that we must wait until more material may be definitely reared from this host before this record can be accepted as one belonging to *M. brevicaudis* Ratz.

It has been already indicated that the genus contains both entomophagous (commonly referred to as parasitic) and phytophagous species. There is a single known example (*Megastigmus* sp. B., Noble, 1940) in which the habit may prove to be one that is transitional between these two groups. That is, the species is said to be phytophagous in its earlier stages, later becoming an external parasite (or predator). This habit is, therefore, not comparable to the "gemischter" type detailed for *Callimome eurytomae* P. M. by Puzanova-Malysheva (1936), or for a few known examples in other genera (see under "Parasites of Megastigmus"). With the exception of three parasitic species in the European fauna, all Palaearctic and Nearctic species, as far as is definitely known, are seed consuming. Biological details of very few Australian and Oriental species are available, but true parasitic and probably true phytophagous species do occur, at least in the Australian Region.

In describing the generalized biology, the intention is to limit such a discussion to the phytophagous forms. But the reader should bear in mind the diversity of food habits already demonstrated in the genus. Omission of a general discussion on the biology of the parasitic forms seems desirable at this time since very few such species are well enough understood. Furthermore, the biologies of the different parasitic forms show deviations that either are common to the species or are the result of host influence and specialization, so that such biologies are best advanced in individual treatments. For these the reader is referred to the section reviewing known biologies.

Soon after mating, the female of phytophagous species deposits the egg entirely within the young or immature seed where all stages are passed to the

adult. There is little or no external evidence of the presence of the larvae except that the experienced eye can often detect older infested seeds by their off color, abnormal texture or rigidity, etc. Never more than one larva attains full growth in a single seed. Growth is rapid and usually by middle or late summer the larvae are full grown and have at that time consumed the entire contents of the seeds. They then remain dormant over winter.

Exceptions to this course in development may be noted with respect to different regions of the world. For instance, in Italy, *M. ballestrerii* (Rond.) (=*pistaciae* Walk.) is said to produce an abnormal population of adults from the end of August to mid-September, the normal population occurring from the end of June to early August (De Stefani, 1918).

Pupation and emergence of the adult from the seed occur within a relatively short period the following spring or early summer. Exceptions to this one year cycle are to be found in certain conifer seed infesting species which are known to exist longer than one winter in the dormant condition. Under normal conditions there is a marked synchronization of the adult emergence to correspond with the time of season when fruits of a particular host or hosts are available and suitable for oviposition. Miller (1916) found that females of *M. spermotrophus* would oviposit in young Douglas fir cones about three weeks old, and which had a length of about one and one-half inches, soft scales, and seeds with milky interior and unhardened coat. Females of *M. nigrovariegatus* Ashm. oviposit before the rose hips turn a pronounced red, and while the endosperm is still jelly-like and the seed coat relatively tender.

With regard to certain conifer seed chalcids, Miller (1914) has pointed out the interesting adaptation to the intermittent cone production of host trees. The following brief extract from his discussion better clarifies this relationship: "The intermittent character of the seed production of conifers is a well established fact. A few cones are produced every year, but a good crop occurs at intervals of from two to five years. The years of total failure are known as 'off years.' It is evident that if the entire brood of any of these species of cone-infesting insects emerges annually, it will sooner or later encounter an off year of the host tree." Miller has observed the retarded emergence of these seed chalcids whereby not all completed their development and emerged the first spring, but a part of them remained dormant until the following spring. "This is an adaptation," he stated, "which to a certain extent accounts for the continued infestation of certain species of insects in the seeds of forest trees." Both MacDougall (1906b) and Crosby (1909) indicated that they had reared *M. spermotrophus* from seeds that were two years old. Apparently under artificial or laboratory conditions, Hoffmeyer (1930a) observed that *M. pinus* Parf., *M. rafni* Hoffm. and *M. spermotrophus* emerged at three different times, *viz.*, the summer of the first year (after oviposition), the following winter, and a small number in the second summer. From seeds of *Abies concolor* Lindl. collected in New Mexico in the fall of 1939 and sent to our St. Paul laboratory, a few specimens of *M. rafni* (both sexes) emerged in the spring of 1940. When the seeds were examined in the late fall of 1941 it was found that they still contained living larvae, both

confirming Hoffmeyer's observation as well as indicating that a portion of the population of this species may be capable of existing longer than two years in the dormant condition. According to Escherich (1938), a "generation" or cycle in *M. suspectus* Borr. may require either one or two years. Referring to conifer seed chalcids in general, Doane et al (1936) state that as many as ten to fifty per cent of the larvae may remain in the seeds throughout the second year.

The exact time of the year when natural emergence takes place depends on the species, geographical distribution (and altitude), and climatic conditions. Dates procured under laboratory conditions are usually of little value, because emergence can be controlled at will, depending on the varying temperature conditions to which infested seeds are subjected. Miller (1916) gave the following times of the year covering maximum emergence of *M. spermotrophus* from seeds under outside conditions: At the laboratory elevation, Ashland, Oregon, between May 1 and 16; at elevations from 3,000 to 4,000 feet, in latter part of May. "Above 4,000 feet, much of the emergence occurred in June." In general, males of the various species usually emerge approximately two to four days before females make their appearance.

The period of flight, used here to refer to the time of the year any part of the adult population may be encountered under natural conditions, obviously depends largely on the duration of the emergence period, and the average length of life of the individuals constituting that population. In their turn, these factors depend on the species, the geographical location (or altitude), climatic or ensuing weather during the period of adult activity, etc. Escherich (1938) gave the period between March to August as the time of flight of conifer seed infesting species. These dates would, of course, mark the extremes in the temperate zone. Few field observations have been published on our native species and the number of specimens captured in their natural habitats is relatively small. From the data of Miller (1916) on *M. spermotrophus,* we know the period of flight in Oregon is in May and June at least, and very probably extends through much of July at higher altitudes. This same species oviposits in September and October at Tapanui, New Zealand, according to Gourlay (1930) and these months may be taken to represent approximately the corresponding period when adults are in flight there. Species which infest the seeds of deciduous trees and shrubs in northern latitudes may be found in flight from May to the latter part of July, with the maximum activity in May or June. According to the work of De Stefani (1918) one might expect to encounter the adults of *M. ballestrerii* (Rond.) (=*pistaciae* Walk.) from June to mid-September in Italy.

In some species there normally appears to be a very low male population, as for example in *M. suspectus* Borr. and *M. amelanchieris* Cush. The writer knows of no authentic record of the male of *M. brevicaudis* Ratz. as understood in this paper, although it may occur. The male ratio is low in *M. aculeatus* (Swed.) and apparently so in *M. pistaciae* Walk. Where this shortage of males does actually exist, it has been suggestive of a regular parthenogenetic mode of reproduction (*Cf.* Seitner, 1916).

SUMMARIES OF BIOLOGIES
(With original notes on certain Nearctic species)

PHYTOPHAGOUS SPECIES

Megastigmus amelanchieris Cushman.—Notes on the biology of this species appeared in the publication by Cushman (1918) from which most of the following is taken. Oviposition occurs during the latter part of May and early June at both North East, Pennsylvania, and at St. Paul, Minnesota. At the latter location in 1941 the population showed a rapid decline about June 5. Young green fruits from three-sixteenths to one-fourth inch are selected in which to deposit the egg. Development is rapid and the larvae attain their full growth soon after July 1, at which time the seed contents are entirely consumed. Also, about this time fruits ripen and begin to fall. Cushman stated that infested seeds are more irregular than non-infested ones, and that they will float on water while the latter sink. Full grown larvae overwinter, pupation occurs in the spring and adults emerge in May.

The egg has not been described or figured, but Cushman figured the larva and pupa and briefly commented on each. The larval instars and numerous other details in the life history await future investigation. When the biology of this species is finally recorded in detail it will most probably be very similar to accounts of *M. brevicaudis* Ratz. and *americanus* Mill., two closely related species which are likewise little investigated. The uncommon occurrence of the male of this species is also a condition associated with *M. brevicaudis*.

The species was previously recorded only from the seed of *Amelanchier canadensis* (L.) Med., but now it is known to occur in the seeds of other species of *Amelanchier* as well as those of *Sorbus aucuparia* L.

At St. Paul, Minnesota, *M. amelanchieris* is heavily parasitized by *Callimome amelanchieris* (Cush.). (See under "Parasites of Megastigmus").

Megastigmus brevicaudis Ratzeburg.—Rodzianko (1908a, b) published the first and only extensive notes on the biology of this species. He was aware that the full grown larva overwinters and that pupation occurs in the spring, followed soon by emergence of the adults. He briefly described the larva, noted the appearance of infested seeds and made a few notes on adult behavior. Very significant was the fact that he verified his previous supposition that the species was actually phytophagous within the seeds of *Sorbus aucuparia* L. The egg and separate larval instars remain undescribed. Rarity of males in this species suggests the possibility of regular parthenogenetic reproduction.

During the course of the present study the following notes were taken on this species infesting seeds of *S. aucuparia* at St. Paul. Under natural conditions in this latitude, females are in flight and oviposit about the same time as do the females of *M. amelanchieris* Cush. Also, the remainder of what is known of the cycle seems to agree with that of *amelanchieris* in most respects. Larvae become full grown during the early part of July and at this time a large proportion of the infested berries drop to the ground before they are fully ripe.

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When the mature larva of this species is removed in March or April from seeds which have been kept outside, it becomes active at the proper temperature and assumes a characteristic bent position, although it is entirely capable of straightening out at will. The mid-intestine is large and filled with a brown material which is very evident through the translucent body wall. Several such larvae were dissected from the seeds in March and kept on moist cotton in vials in the laboratory in order to make observations of changes preceding the imago.

The expulsion of brown or black pellets, which often adhere to the caudal end of the body, is the indication that it is about to become the prepupa. Rapid internal changes now take place and the imaginal buds first can be noted at the ventro-lateral areas of the thoracic segments. Soon the abdomen becomes oval and turgid, and the segmentation is much less evident than in the larva. The lateral aspect of the body is somewhat angulate and there is a distinct differentiation between thorax and abdomen. Toward the end of the second day after these changes have appeared, the prepupa is of a shape similar to that of the pupa. Inside of what was the prothoracic segment of the larva can be seen the pupal head, especially the outline of the compound eye, which at this time may show a faint pink color. In all instances observed in the laboratory, a period of approximately two days was required for the prepupal stage.

The first indication of the coming emergence of the pupa is initiation of bending movements of the body. Pressure exerted on the larval integument at the cephalic end of the body forces a rupture behind the head capsule. Slowly, the pupa, which is itself covered by the pupal integument or theca, forces the larval exuviae backward; this is accomplished by bending movements of the body and expansion and contraction of the abdomen. The entire act normally required about thirty minutes to an hour. Some specimens observed encountered difficulty in freeing the ovipositor and their continued efforts to do so lengthened the completion of the transformation to nearly two hours. Once the ovipositor is freed, it is curved up over the end of the abdomen; the crumpled larval exuviae frequently remains adhering to the distal end of the abdomen.

The pupa is entirely white except for the faint pinkish cast of the compound eye. It measures about 2 mm. in length and 0.7 to 0.8 mm. in width through the thorax. The antennae, legs and wing pads are directed to the under surface of the body where they are firmly attached as in the typical pupa of other species. Color changes first involve the eyes which become increasingly more intense scarlet, and finally they assume a brilliant red prior to the emergence of the adult. The body color appears about four days after pupation, after which the color intensifies gradually, the abdomen darkening more slowly. The pupal period was seven to eight days' duration in the laboratory. Usually movement of the pupa was observed at least a day or more before emergence occurred. Under the pupal theca both the head and pronotum are capable of short, abrupt movements at this time, and the middle and hind legs are frequently forced away from the body except where they

are firmly attached distally. Expansion and contraction of the abdomen, as well as the fact that the theca becomes taut over the head and thorax, are noted features of pupal activity preparatory to emergence of the adult. At more or lss regular intervals the thorax is expanded, followed each time by a sudden contraction. Apparently, molting fluid is forced to all parts of the head and thorax by such activity. Movement may increase until the theca is tightly drawn, and the pupa appears somewhat swollen and glossy, especially on the head and thoracic dorsum. Movements may then subside for a time, after which the somewhat swollen condition disappears, and the now wrinkled theca adheres closely to the body. Initiation of more vigorous movements such as bending the body between the thorax and abdomen, freeing of the legs, and more pronounced movements of the head and pronotum made possible by the flaccid theca, are indications that emergence is about to take place. Details of the final ecdysis are very much like those described for *M. nigrovariegatus* Ashm. Usually about an hour is required but in cases where there was some abnormality evident nearly two hours were required for expelling the theca.

According to our present knowledge, this species has been recorded only from the seeds of *Sorbus aucuparia* L. in North America.

Megastigmus americanus Milliron—Presumably, the biology of this species is very much like that of *M. brevicaudis*. Undoubtedly most of the remarks of Crosby (1909) under the latter name refer to this species. One of the most interesting features, and something deemed significant enough to emphasize at this point, is the data attached to several adult specimens from Canada, revealing that they had been captured at lights. To the knowledge of the writer, this has not been reported for any other species of the genus and more material taken under similar conditions should be sought for verification. Apparently the males of *M. americanus* are not uncommon, since several of them have been examined in this present study.

Megastigmus gahani Milliron—The life history of this species and its immature stages are undescribed. In 1940, males were captured as early as May 26 in southern Minnesota. From observations in the laboratory on sexual behavior, this species has been found to be distinct from *M. physocarpi*. Males are very active and mate with females readily and freely. While courting they make much use of the antennae, commonly vibrate the wings as they are held in a vertical position, and perform other usual behavior that is described for *M. nigrovariegatus* Ashm. When paired females are inclined to move, the wings of the male may be drooped downward and forward at her sides momentarily, and if she persists in moving, this activity may be repeated in rapid succession. Copulation by the male is accomplished from a direct caudal-ventral position and requires twenty to thirty seconds.

This species infests the seeds of *Physocarpus opulifolius* var. *intermedius* (Rydb.) Robins. and possibly other species; it commonly occurs along with *M. physocarpi* Cy.

Megastigmus physocarpi Crosby.—The life history has never been published and none of the immature stages have been described. Emergence

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under natural conditions takes place during the latter part of May, a few days following the appearance of *M. gahani*, when the latter is also present. During the course of extensive rearing of this species, observations in the laboratory revealed a distinct difference in sexual behavior from that of *M. gahani* as indicated under the species. In general, young males seem to show less sexual activity than do older males. Once the male has succeeded in mounting, it becomes much excited and for several seconds may hold the vibrating wings in an inclined position or droop them downward at the sides of the female. Since the male becomes very much excited when courting and often may turn completely around, the female appears to be able to dislodge it with little difficulty. It was especially apparent that females are non-receptive to the males .Though a large number of specimens have been held in vials in the laboratory only a single successful copulation has ever been observed. Copulation in this instance was in a vial containing specimens several days old and required nearly a minute.

Megastigmus pinus Parfitt—Some information on the biology of this North American species has been published by Laidlaw (1931) in Scotland, where it has been introduced and apparently has become established in recent years. Because of the brief account and the limited amount of material which served as a basis for that study, we still know comparatively little about the species. At Balmoral, Ballater, Scotland, specimens have been recorded as emerging from *Abies nobilis* Lindl. seeds in May and June as follows. One male emerged on May 11 and one on June 20; two females emerged on May 18 and one on each of the dates, May 25, June 1 and June 8. The condition under which the specimens emerged was not stated but presumably emergence occurred outside. The females have been observed inserting the ovipositor through the cone scales. Larvae are mature by September, pass the winter as such and pupate in April and May, very much the same as does *M. spermotrophus* Wachtl. One female was recorded as pupating on May 4 and emergence occurred on May 25; a male pupated on June 1 and emerged on June 20. These dates are merely indicative that the pupal period of the female is approximately twenty-one days and that of the male approximately nineteen days. Again, we must assume that the data were procured under natural conditions. The larva and pupa are briefly described and figured. The egg has not been described.

There are no published investigations on this species in North America, where it is commonly reared from the seeds of various species of *Abies*.

Megastigmus strobilobius Ratzeburg—The only account of the life history of this species (as *abietis* Seitn.) is that by Seitner (1916). He observed as much as 50 per cent infestation in spruce seeds (*Picea excelsa* Link). The egg is unknown but both the larva and pupa are described, and the head of the former is figured. Also, brief remarks are given regarding transformation to the prepupal stage. Rearings in the laboratory, as well as in an unheated room, indicated that the time required to complete a generation was three years. Under natural conditions in one of the upper Austrian provinces only two years were required. In order to account for this, Seitner suggested

the possible influence of a difference in the amount of moisture surrounding the seeds under these two conditions. The observed time of flight at the laboratory location was from April 25 to May 9, while at the upper Austrian province referred to above it was from May 2 to May 18. A female of this species was kept alive fifty-nine days when offered artificial food. Further observations, in addition to numerous details in the life history, are lacking.

Megastigmus suspectus Borries—The only available information on the life history is that by Seitner (1916) who, under the name *piceae* Seitn. (nec Rohwer), stated that it requires one to two years to complete its cycle. Under natural conditions in Idria (Krain, Austria) during the first year (1915), forty-six females are recorded as having emerged from a seed sample between May 14-20. During the following year, sixteen females emerged between May 3-6. The egg is unknown, but a brief description of the larva is given and the larval head is figured. Seitner found that isolated females may exist alive fifty-two days when supplied with food. It would seem from these data that females may be found throughout May and June in their natural habitat.

Megastigmus spermotrophus Wachtl.—This is the most widely known of the conifer seed infesting species, chiefly because of its economic importance as a pest of seeds of *Pseudotsuga taxifolia* (Lam.) Britt., yet an exhaustive study of its biology has never been published. In several papers, MacDougall (1906 *et seq.*) treated part of the life cycle and seasonal activity in Scotland, where the period of flight begins in May. Presumably the emergence extends into June under natural conditions. During oviposition adults were observed by MacDougall in Douglas fir trees and over seed beds sometime after planting. He stated the opinion that only a single annual generation occurred, and made several additional observations of a general nature.

In some respects it is unusual that so little effort has been made to study the details of the cycle in North America, because the species is indigenous with us and in certain years, at least, it appears to cause considerable seed destruction. Miller (1916) has published a very interesting account of the oviposition and, in addition, contributed other valuable information on seasonal activity at Ashland, Oregon. Under natural conditions, maximum emergence was observed between May 1 and May 16 at the laboratory elevation; at 3,000 to 4,000 feet, the maximum emergence occurred during the latter part of May; at higher elevations much of the emergence was in June. Just when initial emergence began under such conditions is not stated, but apparently the earliest date would be sometime during the latter part of April at the lower elevations. By caging adults outside and supplying cones about three weeks old, he was able to observe numerous females ovipositing. The detailed account of this activity is essentially like that described for *M. nigrovariegatus* Ashm. except where noted below. The cones offered for oviposition were one and one-half inches long, had soft scales, and seeds with milky interior and unhardened coat. During warm sunny days the females actively engaged in depositing eggs, but during cool rainy weather such activity was not observed. During oviposition, the anterior end of the female is invariably directed toward the base of the pendant cone. Two to five minutes were

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required for each oviposition, and on one occasion a single female was noted performing the operation five consecutive times on the same cone. The surface of a scale was always selected as the location for insertion of the ovipositor, which penetrated to the second or third scale, and then finally turned forward in order to pierce the seed lying ahead of that scale. Obvious difficulty was encountered when females attempted to oviposit in older cones, and Miller has inferred that once cones become hardened it is not likely they can be infested by these chalcids. Oviposition under natural conditions in the field was encountered only once; the female had sometime previously inserted her ovipositor and very soon after she was first observed withdrew it and flew away.

In New Zealand, according to Gourlay (1930), the seeds are attacked when the cones are small and green, as Miller had previously shown. This occurs there in September and October.

The ovarian egg has been figured and described briefly by Crosby (1909), and various workers have given superficial descriptions of the full-grown larva (MacDougall, 1906b; Crosby, 1909; Vayssiere, 1931). Much still remains to be known about the entire life cycle, especially with regard to the immature stages and habits of the species, to say nothing of the general ecological aspects.

As mentioned elsewhere, Miller (1914) early called attention to the adaptation of seed chalcids to the intermittent crop producing tendency of certain conifers. In keeping with other species which infest the seeds of conifers, *spermotrophus* shows a marked adaptation in this respect. Our knowledge of the habits of this species was not sufficiently advanced by 1906 when MacDougall first encountered the phenomenon, whereby adults emerged from two year old seed, and consequently he was unable to offer the correct explanation. Crosby (1909) also reported rearing specimens from seeds that were two years old. About ten per cent of the full grown larvae of this species remain as such through the second year, according to Doane et al. (1936).

Since the appearance of Crosby's (1913) revision, most authors referring to this species have followed it in regarding various species of the genus *Abies,* as well as *Pseudotsuga taxifolia* as hosts. As a result of this present taxonomic study, it has found that *spermotrophus* appears to be entirely restricted to *Pseudotsuga.*

Megastigmus pistaciae Walker—The life history of this species in Sicily, Italy, has been fully investigated by De Stefani (1917, 1918), who published the details under the name *M. ballestrerii* (Rond.).* Eggs are deposited in the young fruits of *Pistacia terebinthus* L. and *P. vera* L. in June to August. Larvae are full grown in September and overwinter in the usual way until May, then transform to pupae and emerge as adults in June and July. Thus, there is but a single annual generation, but due to prolonged summer heat, a part of the larvae may successfully pupate and emerge as adults from the

* This species has been synonymized with *M. pistaciae* Walk. by several European workers, and the writer prefers to accept tentatively this synonymy.

end of August to the middle of September, constituting the abnormal portion of the same generation. Because of the hardness of fruits at this time, such adults which have made their appearance in late August and early September are unable to ovipost. If, in rare instances, some of the females may locate soft young fruits and deposit their eggs the resultant larvae would soon encounter cool weather in September and merge into the normal larval population. All stages of this species are said to be figured and described.

Anagnostopoulos (1938) has given essentially the same life history for the species in Greece, also using the name *ballestrerii*.

De Stefani is of the opinion that the natural host of this species is *P. terebinthus*, a belief supported by the rearing of most of its parasites from infested material of that species of *Pistacia*. Fruits of *P. vera* are larger and parasites appear to be unable to reach the larvae of *M. pistaciae* in most instances. The observations indicate that this species has therefore adapted itself to the economically important *P. vera*, on which the population and attack have increased.

PHYTOPHAGOUS AND ENTOMOPHAGOUS SPECIES

Megastigmus sp. B.—This is a large Australian species of which the complete life history is unknown except for a few biological notes and descriptions of certain immature stages that have been given by Noble (1940). From what is known we may regard it as possibly representing an intermediate or transitional type between phytophagous and entomophagous forms. Immature stages to about the third instar larva apparently live phytophagously in the galls on *Acacia* caused by *Trichilogaster acaciae-longifoliae* (Frogg.). In November and December galls have been opened and found to contain dead pupae of the gall-former, and either full-grown larvae or pupae of *Megastigmus* sp. B; while earlier in November a third instar larva was found along with a normal pupa of *T. acaciae-longifolia*, indicating that the megastigmine allows for larval development and pupation of the host before attacking and devouring it. These observations have led Noble to conclude that *Megastigmus* sp. B. must exist as a phytophagous insect until the pupation of *T. acaciae-longifoliae* and then become an external parasite.

Only the ovarian egg, which is typically megastigmine in every respect, is described. The description of the larval form is confined to the full-grown stage which possesses quadridentate mandibles like those of many phytophagous species. The ventral surface of the head and the entire first body segment are papillate, and the circlets of setae on the thoracic segments are composed of relatively long setae, which are longest on the first and shortest on the third segments. The figure of this stage shows six setae on the first thoracic segment and five on both the second and third, much the same as in *M. nigrovariegatus* Ashm.

In 1936 to 1937, adults emerged from November 14 to January 25, beginning soon after the first host adults appeared. Oviposition in this species has never been observed.

ENTOMOPHAGOUS SPECIES

Megastigmus dorsalis (Fabricius)—The complete biological treatment of any one of the European parasitic species is lacking. Fahringer (1922) offered the best account of this species. According to him, this is a common and widespread parasite of gall-formers (of the Cynipidae), only seldom establishing itself as a parasite of the inquiline *Synergus pallicornis* Htg. (=*S. flavicornis* Htg.) in the gall of *Cynips kollarii* Htg. Fahringer's former observations (apparently not previously published) revealed that the eggs are laid in June and that the first instar, of which there are usually two to four present, attaches itself to the spiracle of the cynipid larva. The larva of *M. dorsalis* overwinters in the gall chamber beside the empty larval integument of the host and transforms to the pupal stage early in March. Under laboratory conditions adults appeared from the latter part of March to the beginning of May, except for two rearings in December. According to Nielsen (1902) this species, along with other parasites, hibernates until April or May in the gall of *Andricus trilineatus* Htg., one of its several cynipid hosts.

Parker (1924) has studied the larval and egg stages in detail as a part of his consideration of postembryonic development in the Chalcidoidea, and any generalizations on *Megastigmus* are based on the stages of this species. As figured, the egg is very similar to that of certain species of *Callimome*. It is elongate with a comparatively short anterior pedicel that is narrower than the body; the sharply pointed posterior pedicel is lacking. Except for minor details, the larval forms approach those of *M. nigrovariegatus* Ashm. in form and structure.

Megastigmus brevivalvus (Girault)—Our knowledge of this Australian species, the first entomophagous member in the genus to be investigated in such detail, we owe to the contributions of Noble (1933-1938a), who presented his biological study conducted in connection with the insect complex associated with galling of citrus. This species is one of the parasites of *Eurytoma fellis* Gir. which is directly responsible for the gall formation.

Although females possess no fully developed eggs immediately after emerging from the pupa, they do contain a number of eggs that are ready for deposition by the time they have cut their way out of the gall. Oviposition may, therefore, occur on the day of emergence. One of the most enlightening facts is the manner in which eggs are deposited. Before oviposition can take place the eggs of the host must have been first laid in the twig. With the aid of the antennae these sites are located by *M. brevivalvus* which deposits its egg entirely within that of the host. Oviposition is described by Noble in some detail. The number of eggs deposited within a single host egg may be as many as four. The age of the host eggs accepted for oviposition does not appear to be significantly important between the known range of from two to thirty-two days. In other words, host eggs may be nearly ready to hatch when they are selected. Noble gave a good account of the incubation period and embryonic development. Since the first instar larva of *E. fellis* remains as such for some months, it is always the first larval stage of the host within

which the egg of *M. brevivalvus* hatches. While the host larva undergoes its development, the larva of this parasite remains as a first larval instar in the haemocoele of its host for a period of approximately eight months, apparently without being detrimental, until the latter has reached the last stage. After this time the parasite transfers to the second instar and continues its development; after having attained its last stage, it devours all the internal contents of the host within a few days. Five larval instars are described, of which the mandibles of the last only are bidentate on the inner margin. The pupal stage, which is also described, lasts from fifteen to twenty-eight days under laboratory conditions with an average of about eighteen days.

The single annual generation, which is very well synchronized with that of its host as to embryonic and larval development, time of emergence, etc., is summarized by Noble as follows: "Allowing for five to six weeks incubation and a pupal period of three weeks, the larval life is approximately ten months, of which at least eight months are spent in the first stage." The winter is, therefore, spent as a first instar larva within the larva of its host. In late winter and early spring the host larvae undergo final molts, permitting *M. brevivalvus* to begin its rapid succession of four molts (all within a few weeks), pupate, and emerge as an adult within a relatively short time. It is generally true that a parasitized larva of *E. fellis* always attains full growth at which time *M. brevivalvus* is still a very small first instar larva, but the parasite's development then becomes so rapid that it is entirely capable of overtaking its host before the latter can ever pupate.

Of more than five thousand individuals reared in a four-year period between 1931-1934, the percentage of males compared to that of females was 62 to 38. Under laboratory conditions the average length of life of males was five days; that of feamles, six days. As would be expected, the average length of life at lower temperature was increased considerably (eight and nine days at 15°C.) and at higher temperature it was reduced (approximately four days for both sexes at 25°C.). Courting and mating is described under laboratory conditions and appears not to differ greatly from that observed in some other species. Experiments conducted in 1932 and 1933 on large numbers of females demonstrated that unfertilized individuals would oviposit freely in host infested twigs. From one of the galls males emerged, indicating that the female is capable of reproducing parthenogenetically with the production of males only.

Thus, the biology of the species as here outlined, and as given in much greater detail by Noble (1938a), is in some respects the most unique of all known species, illustrating a remarkably complex inter-relationship between parasite and host. Two peculiarities are, intraovular deposition of the egg and synchronization of embryonic and larval development with those of the host. According to Clausen (1940) no other instance of this oviposition habit is known in the Callimomidae, and it is rare even in the entire superfamily Chalcidoidea. However, it should be pointed out here the possibility of the same habit in *Megastigmus acaciae* Noble (Noble, 1939).

Megastigmus trisulcus (Girault)—What is known concerning the life his-

tory of this Australian species is confined to some observations published by Noble (1933, 1936, 1938a), especially in the paper dealing extensively with *M. brevivalvus* (Gir.). It has been shown to be a parasite of *Eurytoma fellis* Gir., which has been indicated as the causal agent of galls on citrus. Apparently this species, like *M. brevivalvus,* allows its host to attain its final larval stage before consuming it. The larval stages are undescribed except the last, about which brief comments have been made. The mandibles of this final larval stage are quadridentate and somewhat similar to those of *M. nigrovariegatus* Ashm. In the spring of 1932, it was observed that the adults of this species began to emerge four days after the first adults of *E. fellis* appeared, and fifteen days before those of *M. brevivalvus* (Noble, 1938a, fig. 11, p. 23). Of the 262 specimens reported as having been reared, 56 per cent were males and 44 per cent females. The average length of life under laboratory conditions is about thirteen days for the male and sixteen days for the female. Mating has been observed in glass vials in the laboratory, but no progeny were ever developed under these conditions.

Megastigmus acaciae Noble—This is the second Australian entomophagous species to have practically all essential points known in the life history (Noble, 1938b, 1939). It is one of the insects constituting the complex found in the flower bud galls on *Acacia decurrens* Willd., and occasionally on *A. decurrens* var. *pauciglandulosa,* as an internal parasite of *Teperella trilineata* Cam., which is responsible for the gall formation. In the spring (October and November) females of *M. acaciae* locate infested buds and deposit their eggs either within the host egg or within the first instar larva of the host, a point which Noble was unable to ascertain. The egg is very similar to that of *M. brevivalvus.* After the act of oviposition the females under observation always took flight to other flower buds. However, more than a single egg may be deposited in a given host individual, as is evidenced by the fact that two larvae of the parasite have been dissected from a single host larva. And, two parasitic larvae may develop simultaneously in the same host larva until it has attained the third and fourth instars, but only one of the parasites is able to complete its development. The summer, autumn and winter are spent in the larval stage within the host, but since it remains small during this time and feeds on the body fluids in the haemocoele apparently little harm results, and the host is allowed to complete its larval development much the same as *E. fellis* (Cf. *M. brevivalvus*). After the last larval stage of the host is attained (usually between June to September inclusive) the parasite undergoes a series of rapid molts and soon after reaching its last larval stage it devours the contents of the *T. trilineata* larva. Consequently, parasitized host larvae are never allowed to pupate. Five larval instars have been described in detail for *M. acaciae,* all of which are very similar to corresponding stages of *M. brevivalvus.* Activity preparatory to pupation and the pupal stage are also described.

Emergence of adults from the host galls occurs in the spring as previously inferred; October 2 to November 8, or a period of thirty-eight days, was the observed time in 1936, with maximum emergence during the second half of October. Early in the emergence period males outnumbered females but later the reverse was true. Of a total of more than 1,500 adults that

emerged in 1936, 65 per cent were males and 35 per cent were females, or a male-female sex ratio of about 2 to 1 (*Cf. M. brevivalvus*). Under laboratory conditions the average length of life for both males and females was about five to five and one-half days. Mating was observed to occur in vials in the laboratory, the procedure of courting and copulating being virtually the same as in other species.

Eurytoma gahani Noble, another member of the complex in the flower bud galls on *Acacia* (Noble, 1939, 1940), is at first phytophagous and later becomes entomophagous, acting as a parasite (or predator) of the larvae of *T. trilineata* and *Tr.chilogaster acaciae-longifoliae*. When present this external parasite devours its host along with any *M. acaciae* that may be within the *T. trilineata* larvae. Consequently, we must regard *E. gahani* as an enemy of *M. acaciae* in an indirect manner.

The description of *M. acaciae* and a discussion of its biology have formed the subject of the detailed paper by Noble (1939) from which the above information has been taken. Information on *E. gahani* as a parasite of *T. acaciae-longifolia* appeared in a later paper by the same author (1940).

BIOLOGICAL STUDIES ON MEGASTIGMUS NIGROVARIEGATUS Ashmead WITH DESCRIPTIONS OF IMMATURE STAGES

When this species was described by Ashmead in 1890, he knew nothing about its habits. Five years later, Cockerell (1895) published the first biological observations while in New Mexico. In his notes for June 25, 1894, he mentioned observing specimens on rose fruit, and that these "dropped or jumped backward instead of attempting to fly." Even at this early date he suggested the probability that they infest these fruits.

Though Crosby (1909) had not separated this species from *M. aculeatus* (Swed.) in his first general paper on seed chalcids, it is reasonably certain that at least some of his remarks on biology apply to *nigrovariegatus*. He noted that the full grown larvae overwinter and that they pupate in the spring. Oviposition was also observed and the months for such activity stated to be June and July.

Early in the study of *Megastigmus* it was realized that *M. nigrovariegatus* is by far the most common species of the genus in Minnesota, and that material could be produced easily at all times. In addition, the preferred host plant, *Rosa rugosa* Thunb., was common enough to make large quantities of infested seeds accessible, and to permit observations on general activity throughout the season. Consequently, in conjunction with a taxonomic study, the following biological investigation was begun in the spring of 1939 with the intention of procuring as much information as possible during the time allotted. The material which follows is by no means offered as an exhaustive biological treatment; that there are still a number of points in need of clarification is fully realized.

All data from field and laboratory studies on this species were obtained at St. Paul, Minnesota, between April, 1939, and October, 1941.

THE EGG

The egg of *M. nigrovariegatus* (Figs. 32 and 34) is composed of three parts: A long, narrow anterior pedicel; an elongate-oval body; and a short, spur-like posterior pedicel. Ovarian eggs (Fig. 32) which were measured have a total average length of 0.985 mm., the separate parts being as follows: Anteriol pedicel, 0.724 mm.; body, 0.244 mm. long, and 0.078 mm. wide; posterior pedicel, 0.037 mm. The color of the ovarian egg is grayish white, it is turgid throughout, and the entire surface is smooth, shining and lacks ornamentations.

Eggs are deposited entirely within the jelly-like mass surrounding the seed embryo, and the end of the anterior pedicel is attached usually to the side of the innermost envelop of the endosperm. It is not uncommon to find two or even three eggs in a single seed. After the egg is deposited the posterior end of the body usually becomes slightly attenuated, and the entire egg is somewhat more elongate. The anterior pedicel becomes narrower and, finally after its collapse, is ribbon-like except frequently the extreme distal portion may retain its original shape (Fig. 34). The posterior pedicel is either conspicuously extended or recurved toward the body of the egg and sometimes appressed to its surface. Sometimes the posterior pedicel is entirely inconspicuous or wanting. The average total length of a limited number of eggs measured after their deposition is 1.477 mm. Average dimensions of the individual parts of such eggs are as follows: Anterior pedicel, 0.942 mm.; body length, 0.393 mm., and width, 0.125 mm.; posterior pedicel, 0.042 mm.

The egg of *M. nigrovariegatus* agrees in form with that described and figured for *M. brevivalvus* (Gir.) by Noble (1938a), but in the latter species it is said that the short pedicel is anterior and that the long pedicel is posterior. Exactly the same comparison can be made with the egg of *M. acaciae* Noble (Noble, 1939). Clausen (1940), in reviewing the paper dealing with *M. brevivalvus*, indicated that the egg described for that species differs markedly from the characteristic callimomid egg which has the stalk (or long pedicel) normally at the anterior end. The disagreement that now exists between the egg of *M. nigrovariegatus* (also other phytophagous species) and those of the Australian species possibly may be the result of misinterpretation as to which end of the egg *in situ* represents the anterior pole.

On the other hand, Noble (1938a) has figured embryonated eggs of *M. brevivalvus* which show that the cephalic end of the late embryo is directed toward the end of the egg with the short pedicel, which would therefore indicate that the long pedicel is posterior. In *M. nigrovariegatus* the opposite condition is encountered, demonstrating that the long pedicel is anterior.

Dissections of the meroistic-polytrophic ovaries of several gravid females revealed the presence of 10 to 25 fully developed eggs per female. In all probability single females deposit more eggs than this range would seem to indicate, but this point has not been determined. No attempt has been made to discover the maximum number of eggs a female is capable of producing, obviously because of the indeterminate number of developed eggs contained in each ovariole.

INCUBATION PERIOD AND THE EMBRYO

The incubation period has not been ascertained under natural conditions, but observations indicate that it is relatively short and probably does not exceed four or five days.

Late embryos vary somewhat in dimensions depending on the size of the egg. The average length of those examined is 0.228 mm., and the average width, 0.102 mm. In all instances the cephalic end of the late embryo was noted as being directed toward the anterior end of the egg (Fig. 33), a point that has been emphasized previously. Prior to hatching, the embryo is separated from the chorion and is surrounded by a colorless fluid. At this early stage in the development, shortly before eclosion occurs, a very simple respiratory system, consisting of a delicate longitudinal trachea in each lateral region, can be seen in specimens placed in glycerine. The mandibles of the late embryo are conspicuous and by their outward movement appear to rupture the chorion at the time eclosion occurs.

LARVAL DEVELOPMENT AND LARVAL INSTARS

It has been pointed out that more than one egg may be placed within a single seed. If such be the case and the resulting larvae do not come in direct contact with each other they may continue to develop through approximately the third instar. Increase in size of the seed embryo, as well as increase in size of the larvae themselves eventually force them into contact with each other and cannibalism results. Frequently two or three larvae, representing as many instars, are found in a single seed but in no instance does more than one complete its larval development. The occurrence of more than one young larva per seed is especially common during the early part of the oviposition period. During this time, when the seed embryo is yet comparatively small, the greater part of the seed content is watery to jelly-like in consistency, and the young larvae may be located almost anywhere inside consuming this material without any apparent damage to the seed or without impairing its growth. As the seed embryo grows, the surrounding medium becomes grayish white and paste-like, and at or during this stage a larva is commonly forced to the distal end of the seed or it may come to lie to the side of one of the cotyledons. In either event, when the larva is ready to begin feeding on the cotyledons there is every assurance that it will not begin at the base of the seed embryo, which continues to enlarge and provide ample food for the larva to complete its development. The outer covering of the endosperm mostly remains intact until the later larval stages are attained when it is then consumed along with the basal portion of the embryo.

The larva develops rapidly, passing through all stages within a relatively short period according to observations made in the spring and early summer for three consecutive years. In 1939 the earliest possible oviposition could not have been much before the middle of June, and by July 19, full-grown larvae were commonly dissected from the seeds. In 1940 almost identical results were observed. In 1941, the season being advanced by two weeks, the first observed adults (almost exclusively males) were seen on May 30. Oviposi-

tion that year could not have occurred before the first week in June for two reasons: First, rose hips were unsuitable for oviposition until that time; and secondly, close observation revealed that the females did not manifest the slightest desire to ovipost until about June 4, shortly after which the first oviposition for that year was observed. On June 30, numerous specimens, which had attained the last stage but which were not full-grown, were dissected from seeds in the rose hips kept under observation. These records therefore indicate that all larval development takes place within a period of a month or slightly less. The duration of the individual larval instars has not been ascertained.

Molting is commonly observed in connection with larvae that have been dissected from the seeds and placed on the surface of distilled water. When a molt is about to occur the specimen becomes slightly flaccid and relatively inactive. At the time of molting, the integument over the dorsum of the thorax is ruptured and the larva gradually and slowly forces the delicate exuviae backwards. In younger instars usually the exuviae is expelled *in toto* at the caudal end of the body, but with more advanced instars the old integument may rupture at various additional points after molting has begun, and frequently after the process is completed parts of the head capsule and the mandibles may be found adhering to the sides or venter near the median region. The newly molted specimen usually remains contracted for a time after the molt and does not attain any immediate appreciable increase in size. Thus, any change in superficial appearance from one instar to another is very difficult to detect.

In investigating the number of instars, all body measurements were made of living specimens dissected in distilled water, and descriptions of the instars refer to the same type of material. Dimensions of the instars are given as minimum and maximum to assist in recognizing more readily the different sizes of specimens that may be encountered in a given instar. With respect to the body measurements for certain stages, it will be noted that the maximum dimensions of one instar may overlap the minimum of the succeeding instar. This becomes apparent when a rather large sample of specimens is studied. Undoubtedly, if more material had been measured the same would have become obvious between all instars, clearly indicating that the use of size alone cannot be relied upon for separation of specimens at the extremes. By procuring specimens of the different stages it was possible to observe molts between all instars and to mount the mandibles in series of two representing consecutive instars.

This species undergoes five instars in its larval development. These were ascertained originally by size, shape and degree of sclerotization of the mandibles, and by the presence of setae on the body segments. In order to check the instars as discovered by using these characters, a limited number of width measurements of head capsules were made, and these likewise indicate that five instars do occur. The size of the head capsule appears to be very significant as an aid in recognizing certain instars, such as the second, third and fourth, which usually offer much difficulty. This is especially true since mandibles are not always entirely constant within the range of a particular instar.

For example, at the initiation of an instar the mandibles may appear less heavily sclerotized, or lighter amber than they do at the time when the specimen is about to molt to a succeeding instar. Likewise, mandibles vary somewhat in shape and the basal tooth is not always constantly present, or of the characteristic shape and size. The larger setae, which are present on the fifth instar readily distinguish it from the fourth. These setae are best observed when specimens are magnified eighty-five or more times.

First Instar—The first instar (Figs. 35 and 36) possesses a head and thirteen body segments. It is minute, translucent grayish white except in the region of the alimentary tract which may be very pale yellowish green in individuals approaching the second instar. The head capsule, which is only slightly narrower than the first thoracic segment, is distinct; under very high magnification minute, blunt tubercles are visible, indicating the location of the antennae which gradually become somewhat more obvious in each successive instar, though they are never very conspicuous. The average width of the head capsules measured is 0.15 mm. Immediately after hatching from the egg the body segmentation may be somewhat obscured for a time, but soon it becomes more defined. All segments are devoid of setae. The greatest body width occurs through the head and thoracic segments, and each succeeding abdominal segment decreases noticeably in width, giving a pointed appearance posteriorly. The area occupied by the alimentary tract is comparatively small. In newly hatched specimens the non-functional respiratory system may be detected but later it is usually obscured. Specimens of this instar examined range in length from 0.298 mm. to 0.444 mm.; in width the dimensions are from 0.144 mm. to 0.216 mm. The sharply edentate mandibles (Fig. 39) are entirely pale amber and in position they overlap at the tips; their length is from 0.026 mm. to 0.029 mm.

Second Instar—Specimens of this instar closely resemble those of the first but the body tapers more gradually posteriorly, and the relative width through the thoracic segments is increased so that the proportionate size of the head is smaller with respect to the first thoracic segment. Body segmentation is distinct throughout. Specimens are translucent grayish white except in the region of the alimentary tract which is pale yellowish green. Setae are absent on the body segments. The respiratory system is not readily observed in living material but when individuals are mounted in glycerine they show an advanced development of the lateral longitudinal trachea as compared with the first instar. The average width of head capsules measured is 0.19 mm. Body length of specimens examined ranged from 0.451 mm. to 0.686 mm., and the width from 0.188 mm. to 0.380 mm. The quadridentate mandibles (Fig. 40) are strikingly different from those of the first instar; they are pale amber only at their tips and the sharply pointed teeth are more distinctly separated than in succeeding instars; mandibles of this instar vary in length from 0.038 mm. to 0.043 mm.

Third Instar—Specimens of this instar are less attenuated posteriorly and are more noticeably arched (Fig. 37). They are grayish white but less translucent than in the preceding instars. The region of the alimentary tract is

more extensive so that it now occupies a comparatively large area, which appears somewhat yellowish or lutescent. The developing respiratory system and body segmentation are more conspicuous than in either preceding instars. No discernible setae are present on the body segments The size of the head is proportionately smaller, its width being within the range of 0.23 mm. to 0.26 mm. Specimens examined vary from 0.657 mm. to 0.950 mm. in length, and from 0.394 mm. to 0.496 mm. in width. The quadridentate mandibles are larger, more heavily sclerotized and therefore deeper amber at their tips, and the teeth are more closely set (Fig. 41); the length of mandibles associated with specimens of this instar varies from 0.052 mm. to 0.058 mm.

Fourth Instar—Except for a slight increase in size, specimens of the early fourth instar are very much like those of the late third. In fact, the two instars resemble each other so closely that they are the most difficult to distinguish by superficial appearance. The body is less tapering and more strongly arched, and the alimentary tract is larger, much more conspicuous, and usually is pinkish, giving a similar tinge to much of the median region of the specimen, which is otherwise grayish white. The head is now distinctly smaller than the first thoracic segment; the width of the head capsules measured varies between 0.32 mm. and 0.35 mm. Body segmentation is very pronounced but the characteristic folds of the abdominal region as found in the fifth instar are absent. A few minute, short setae may be present on the thoracic segments, but this instar is at once distinguished from the fifth by the absence of the comparatively long and conspicuous type of seta which the latter possesses. The well developed respiratory system is now very distinct. In length, specimens of this instar vary from 0.940 mm. to 1.314 mm., and in width from 0.496 mm. to 0.837 mm. The shape of the mandible is very much like that of the third instar but, in addition to being larger, it is deeper and more extensively amber (Fig. 43); the length has been found to vary from 0.060 mm. to 0.070 mm., but the majority of measurements are 0.065 mm. or above.

Fifth Instar—Immediately following the molt to this instar, larvae usually have the head, first thoracic and the last three or four abdominal segments whitish. However, many early fifth instar larvae appear almost entirely pink due to the absence of masses of fat bodies that later obscure the color of the alimentary tract. It is in the pink colored specimens that the highly ramified respiratory system is best seen in living material. An anterior transverse connecting trachea is found in the extreme posterior region of the head, and a less evident posterior transverse connective in the eleventh body segment (or eighth abdominal segment).

As the larvae attain their full growth (Figs. 38, 45 and 48) the body becomes more strongly arched, the cephalic end being now only slightly larger than the caudal end; the surface is distinctly creased, *i. e.*, the intersegmental folds are conspicuous, and characteristic folds are present on the sides of the more anterior abdominal segments. Because of the accumulation of fat bodies, full-grown specimens are almost entirely white in color and the respiratory system is difficult to detect. The head capsule is rather rigid and, except for a median dorsal depression, it is somewhat hemispherical in outline when dis-

sected from the body (Fig. 42); the width of the head capsules measured varies from 0.41 mm. to 0.43 mm. The antennae are represented by very small, inconspicuous tubercles. The larger setae on the head are somewhat variable in number and position, but usually they consist of a pair between the antennae, and a single seta dorsad and another laterad of each mandibular base. On the median frontal surface in figure 42 is shown an additional pair which could not be located on all head capsules examined. The quadridentate mandible is more broadly and somewhat more bluntly toothed, and is darker in color throughout, especially basally where the color intensifies with age of the specimen (Fig. 44); the length of the mandibles of larvae in this instar vary from 0.080 mm. to 0.088 mm. Each thoracic segment possesses a circlet of setae, constituting the following variable arrangement on each segment. The first segment has six or seven setae on each side (usually six on a side, or six pairs in the complete circlet), of which the lowermost four are by far the largest and most conspicuous; the second segment shows a variation of from four to seven on either side (usually five or six, or an average of five or six pairs in the complete circlet) all of which are correspondingly smaller than those of the first segment; on the third segment there is also a range of from four to seven on either side (usually five, or five pairs in the complete circlet), these being much smaller than those of the second segment. The first eight abdominal segments, or body segments four to eleven inclusive, each possess two pairs of setae of which one seta is latero-dorsal in position, and the other behind the location of the spiracle. The ninth abdominal segment, or twelfth body segment, has three pairs of setae of which one seta is latero-dorsal in position and two are latero-ventral. The last abdominal segment possesses two pairs of dorsal setae and one pair of rather widely separated ventral setae.

Larvae assigned to this instar vary in length from 1.332 mm. to 2.929 mm., and in width from 0.666 mm. to 1.488 mm. The minimum dimensions represent those of a specimen immediately after it had molted to this instar.

A complete, general study of the chalcidoid larvae was published by Parker (1924). This authority has classified them into seven groups, and more recently Phillips (1927) proposed an eighth group based on the larva of *Harmolita tritici* (Fitch). After making a thorough study of *M. dorsalis* (Fabr.), Parker assigned larvae of *Megastigmus* to his Group II, of which in part he said, ". . . each body segment bears on its anterior border a band of minute setae, visible only under high magnification; the thoracic segments each possess three pairs of sensory tubercles of which one pair is located above the spiracular line, one pair immediately below this line and the third pair on the ventral region mesad of the imaginal bud of the leg; the abdominal segments, except the last, bear two dorsal pairs of setae but the ventral pair is wanting" (Translation). However, in describing the mature larva of *M. dorsalis* on pages 304 and 305, he gave the following as part of the complete diagnosis: Seven pairs of setae on segment I; five pairs on segments II and III; two pairs on segments IV to VIII inclusive, X and XII; three pairs on IX and XIII. He neglected to mention segment XI, but his figure of the full grown larva (Figure 177) shows but one seta on that segment. If Parker's description and figure of the full grown larva of *M. dorsalis* are compared with the diag-

nosis of Group II it will be noted that evidently there is some disagreement with respect to the number of "sensory tubercles" present on each thoracic segment.

The larva of *M. nigrovariegatus* might well be placed in Parker's Group II since it agrees closely enough with the description and figure of *M. dorsalis*, with few minor exceptions, *e.g.*, the comparatively minute, inconspicuous antennal tubercles. In summarizing the variable arrangement of the setae as found laterally on the larva of *M. nigrovariegatus*, the following is the usual condition: Segment I with six setae; segment II usually with five to six setae; segment III usually with five setae; segments IV to XI inclusive each with two setae; segments XII and XIII each normally with three setae.

PREPUPA AND PUPA

After larvae attain their full growth they remain as such for the remainder of the summer and through the fall and winter months. Sometimes during the spring, depending on weather conditions, they transform to the remaining stages of immature development. At St. Paul, Minnesota, this transformation occurs during the latter part of April or the early part of May.

Larvae about to change to the prepupal stage are sluggish and somewhat contracted, but there is no appreciable change in color. The unmistakable indication that a specimen is about to immediately become a prepupa is the expulsion of black pellets from the alimentary tract (Figs. 46 and 47), which now for the first time is functionally continuous in the posterior body region in eliminating this waste material that was accumulated during larval development. Light colored pellets may also be found intermixed. The body of the larva becomes more strongly arched and rather rapid changes now occur in transforming to the prepupa. The initial changes are noticeable on the dorsal region of the abdomen which becomes more evenly arched and begins to appear smoother. Changes in other parts of the body occur simultaneously, so that when the complete prepupal stage is finally reached the form appears somewhat intermediate between larva and pupa. The larger abdominal region is more or less smoothly arched and is distinctly differentiated from the thoracic region, of which the lateral and latero-ventral surfaces bear conspicuous imaginal buds marking the approximate locations of the wing pads and legs of the future pupa. What is to be the head of the pupa can be seen within the first thoracic segment of the former larva, the head capsule of which assumes an antero-ventral position. The prepupal stage (Fig. 46) has an average duration of about three days under laboratory conditions. At the end of this time the body color is duller or somewhat yellowish, and the eyes may be faintly pinkish.

Prior to transforming to the pupa, which is a comparatively rapid process, the integument becomes slightly flaccid and weak body movements are discernible. Apparently the pressure applied at the anterior dorsal region by the contractions of the pupal abdomen causes the initial rupture of the larval integument on the thorax behind the head. The larval integument, which is slowly forced backward chiefly by the contractions and expansions of the abdomen, is removed *in toto* but often adheres as a crumpled, compact mass

at the extreme caudal end of the abdomen. The time required for the entire process is variable but usually does not require more than one or two hours.

If larvae which are about to become prepupae are unduly disturbed when they are dissected from the seeds they may proceed to the prepupal stage but never emerge from the last larval integument. Such specimens have been kept alive for approximately a month without further external change, though their color became distinctly darker after a week or ten days.

Newly formed pupae (Figs. 47 and 49) are usually entirely white but gradually within a few days the eye becomes distinctly pink, this being the first part to make any appreciable change in color following pupation. After about six days the eyes of both sexes are deep crimson and the hind tibiae appear light brown. Female pupae after about nine days are nearly entirely light brown except the vertex, temples, occiput, anterior margin of the mesopraescutum and a median dorsal spot on the abdomen, which are black; the wing pads are dark gray and the ovipositor sheath appears as a dark, narrow line. At the same age, male pupae are, as rule, darker brown and the black areas are more extensive, especially over the abdominal dorsum. Color of the brown regions of both sexes continues to intensify with age.

The following are descriptions of the sexes in the pupal stage a short time prior to emergence as adults.

Female—Length, 2.6 mm.; width through thorax, 1.4 mm. (Measurements of a single specimen) (Figure 50). Head directed ventrally with the tips of the mandibles opposed to the front coxae; antenna extended outwardly, then caudo-ventrally, crossing the base of the eye and attaining the front tibia or anterior margin of the front wing pad. Front leg closely applied to the side of the pronotum behind the head, its tarsus visible anterior to the curved distal end of the antenna; middle leg applied to the thorax between the front femur and wing pad, with only the distal end of its femur, the proximal end of its tibia, and its tarsus visible, latter closely applied to the abdominal venter; proximal portion of hind femur concealed, the remainder of the hind leg beyond entirely visible, its tibia extending to beneath the abdomen, and its tarsus also closely applied to the abdominal venter. Front wing pad extends caudo-ventrally, completely concealing the hind pad and parts of the legs indicated above. Ovipositor evenly curved around and above the median dorsal region of the abdomen, closely appressed except the distal end which continues forward nearly to the anterior margin of the propodeum.

Color brown and black. *Head*: Mostly dark brown except the vertex black; and a circumorbital band entirely light brown though sometimes interrupted posteriorly; gena lighter brown; eye deep crimson; mandible brown, its tip dark amber; antenna dark brown or nearly black. *Thorax*: Mostly brown except the anterior margin of the mesopraescutum black. Front wing pad light brown at the base, blackish brown distally. Legs light to dark brown. *Propodeum*: Black, with a nearly transparent median ridge formed by the pupal theca immediately beneath the recurved ovipositor. *Abdomen*: Light brown except an irregular dark brown or black median dorsal patch beneath the ovipositor. Ovipositor sheaths black, distinctly separated, the area between translucent grayish white.

Male—Length, 2.4 mm.; width through thorax, 0.9 mm. (Single specimen) (Figure 51). Except for the description applied above to the ovipositor, the male pupa resembles that of the female in all important details. Male pupae are frequently much darker, with black areas frequently appearing along the anterior margin of the pronotum. Very dark males are almost entirely black. On many specimens the hind tarsus attains the distal end of the abdomen, of which the segmentation in general appears to be more definite than that of the female abdomen.

Under laboratory conditions of average room temperature in early spring, the duration of the female pupal stage varied from thirteen to sixteen days; that of the male was about twelve days. Under conditions of cooler outside temperature, this period is probably considerably longer. On the other hand, full grown larvae retarded until July, when both outside and inside temperatures were approximately the same, passed through the pupal stage as follows: Female, twelve days; male, eight days.

Activity of the pupa is noted readily a day or more prior to emergence of the adult. Coincident with this activity, the theca becomes turgid and glossy, a condition most noticeable on the head and thorax. However, before the actual molting process begins this turgity is relaxed and the theca is no longer glossy and smooth, but becomes greasy in appearance. Initial activity usually concerns movements of the head and hind legs, but the pronotum is also capable of limited movements. As a result of the increased activity, as well as concentration of pressure on the cephalic end apparently brought about by contractions of the abdomen, the theca is ruptured transversely immediately behind the head or across the pronotum. The wing pads are freed distally and are extended caudo-laterally. Most of the theca behind the point of rupture is removed posteriorly and discharged at the caudal end of the body, while that portion still entirely intact on the head and antennae is eliminated with the aid of the front legs (laboratory observation) usually after the remainder of the body is completely freed. As the theca is pulled backwards, exposing the bases of the wings and allowing them to expand, it is noted that a quantity of fluid is gradually forced into the wings; they become somewhat thickened and remain in that condition until completely freed. Evidently this phenomenon is performed in order to create pressure which appears to be the principal means of removing that portion of the theca covering the wings. Intermittingly during the molt, additional fluid seems to be forced into these structures to maintain the necessary pressure as their area increases. If a wing is punctured at the base with a minuten nadeln at a time when only about one-third of it is exposed, allowing a sufficient quantity of the fluid to escape, further removal of the wing covering is never successfully accomplished. The abdomen, by its expansions, contractions and bending movements, plays a most significant role in this molt, although once the theca passes to that region the hind legs may also be employed to good advantage.

Ecdysis as it actually occurs within the limited space of a seed may vary slightly from the procedure as outlined from the laboratory observations made on specimens dissected from seeds and placed in an unlimited space.

Specimens under observation in the laboratory usually remained relatively

inactive for about a day or more after having emerged from the pupal theca. This period of little activity probably corresponds, under natural conditions, with the time normally required by individuals in liberating themselves from the rose hip, which is accomplished through exit holes cut by the mandibles. Even after having emerged from the rose hip by their own efforts, some time is still required for drying and hardening the wings, and for removing any adhering portions of the theca before they become very active and indulge in flight.

The exit hole is always perfectly circular, its diameter being very close to 0.7 or 0.8 mm. Its size naturally depends on the size of the specimen emerging, since the diameter is never any larger than just enough to accommodate an exit.

LENGTH OF THE LIFE CYCLE

It has been adequately shown that *nigrovariegatus* has but one annual generation. However, a varying amount of time may be subtracted from the approximate twelve-month period normally required for the life cycle of subjecting infested seeds to warm temperatures at different times of the late fall or winter. The length of the cycle may be reduced as much as six months by forcing. For example, in one experiment oviposition occurred in early June and in late summer the infested seeds were gradually lowered to a temperature of 0°C. or slightly below, and held for approximately a month, after which they were gradually returned to room temperature. A few males emerged from these seeds during the middle of October, demonstrating that the species may actually complete its entire cycle within a period of six months in the case of special treatment.

SEASONAL ACTIVITY OF THE ADULT

Time of Emergence—In the latitude of St. Paul, Minnesota, emergence begins during the latter part of May or the early part of June. From unpublished data on file in the Division of Entomology, University Farm, collected in 1914 by O. G. Babcock, *M. nigrovariegatus* began to emerge outside that year about June 4, from a large caged sample of rose hips which was collected in November, 1913. The daily rearings recorded at that time further show that the largest numbers emerged on June 15 and 23, and that high numbers appeared consistently between June 22 and 26, after which the emergence decreased gradually to July 7. With the exception of a few individuals that appeared on July 9, no further emergence occurred. These data correspond with the writer's observations made in 1939 and 1940, when the largest populations and maximum adult activity were noted during the second and third weeks in June. The earliest date on which individuals were observed outside in 1941 was May 30; since the population at that time consisted of males almost exclusively, initial emergence probably did not begin before May 27.

In general, males make their appearance about three days in advance of females, and reach their maximum emergence a few days after the latter have begun to emerge. In more restricted numbers they continue to appear along

with females throughout the period of emergence. They may be observed actively surveying the foliage and making short, unsteady flights in attempts to locate the females, which are less active and frequent the undersurfaces of leaves for a time after emerging. Neither sex is a strong flier and consequently seldom indulges in prolonged flight. After emerging, individuals normally remain in close proximity to the host plant bearing the seeds from which they came.

Mating—Mating has never been observed in the field, though undoubtedly it occurs commonly. Perhaps it usually takes place on the undersurfaces of the foliage, in which case successful observation would be mostly a matter of chance, influenced by a number of variable factors.

Under laboratory conditions, mating occurs very commonly in vials or other containers, usually within a few hours after the females emerge from the seeds. However, in a limited confinement with a relatively large population of males aged several days, copulation may occur within the short period of fifteen or twenty minutes after emergence of the female.

The procedure in mating is essentially like that described by Noble (1938a) for *M. brevivalvus* (Gir.). Upon approach, the male momentarily examines the receptive female with his antennae, becomes much excited and immediately takes a mounted position. In initial courting, the antennae of the male are vibrated rapidly while they are in close proximity to, or touching those of the female. Also, a characteristic courting behavior of the male is the momentary elevation of the vibrating wings to a vertical position, during which he usually surges somewhat downward and forward, often touching the female's scape, pedicel or head with his mandibles. The wings may be elevated in such a manner several times before copulation is attempted. If the female is especially inclined to move actively about, the male may droop his wings forward at her sides and hold them there momentarily each time. When ready to copulate, the female slowly elevates the abdomen and lowers the sterna in order to expose the genital opening. Instantly, the male is in place and may copulate from one of two positions; either almost caudo-lateral, or directly caudal. A small male usually copulated from the caudo-lateral position. In either case, he quickly moves backward, bends the abdomen into a ventral position and clings to the female's wings, side of the abdomen or ovipositor. Copulation usually requires between fifteen to twenty seconds, although much shorter and longer periods have been recorded. During this time the female remains in a stationary position with the abdomen elevated. After copulating, the male again immediately remounts directly from the *in copula* positon, and proceeds to repeat his courting behavior. The reason for such characteristic activity is unknown, because no instance of a second consecutive copulation has ever been observed, the male always eventually leaving of his own accord, or being dislodged by the female. As a rule, females mate more than once. If a limited number are isolated upon emergence and after two or three days are united with very active males, which were also isolated for several days, an occasional female may mate with as many as three different males in relatively rapid succession. On the other hand, non-receptive females can easily dislodge a male, or refuse to mate regardless of the number of courtings.

Large males are usually not successful in mating with small females, but the reverse is encountered commonly. Small, light colored females reared from seeds of *Rosa palustris* Marsh., collected in Virginia, mated only with small males reared from *R. rugosa* Thunb., collected in Minnesota, when caged with both large and small individuals. These were later confined in cages containing hips of *R. rugosa* in which they oviposited readily.

NOTE.—This demonstrated that forms of *nigrovariegatus* from different species of roses can be crossmated, especially when the sexes are compatible in size. Furthermore, in experiments conducted to date, it has been found that these forms are not host specific. For example, cage experiments on *R. rugosa* have involved fertile and infertile females reared from other species of roses, notably *R. blanda* AIT., with the result that *R. rugosa* hips were accepted and progeny were produced.

Oviposition and Associated Behavior—Females may begin to oviposit in early June and continue until shortly after the middle of July. Much depends on the earliness of the season and the prevailing weather conditions. In 1939 the peak of oviposition appeared to be during the third week of June, and by July 10 such activity had either ceased completely, or it was of so wide spread and infrequent occurrence that it was not observed. Notes made in 1940 coincide with the condition in the previous year, except that females were seen ovipositing until the middle of July; this was followed by a very rapid disappearance of the population. In 1941 the females began to oviposit as early as June 5, and the peak of oviposition was attained by the middle of that month; the population then declined gradually so that between July 3 and 11, not a single female was found ovipositing and very few specimens were taken even by vigorously sweeping different rose species. During the middle of July of that year, a second crop of rose hips (*R. rugosa*) was produced and was attractive to a few remaining females which oviposited until July 22, after which no further activity was noted.

Dissection of the ovaries revealed that newly emerged females do not contain eggs ready for deposition. This explains the lack of any desire for oviposition on the part of young females until after some time has elapsed, allowing for mating and full development of the eggs. When females are prepared to begin ovipositing there is a notable change in their behavior; they now much more intently frequent the ends of the branches where fruits are borne, in anticipation of depositing their eggs. Many rose hips by this time have attained a diameter of about one-half inch or slightly more; they are still green and contain soft seeds in which the cotyledons are small and enveloped in a watery or jelly-like medium. Ordinarily rose hips such as these constitute the type in whilch early egg depositions are made, but as the season progresses somewhat older fruits must be selected. Rose hips are entirely unsuitable for oviposition after they become red and contain seeds with hard coats and firm cotyledons.

Oviposition is commonly observed in the field. If one is cautious he is able to come within surprisingly close range, because females are not frightened easily when due care is exercised in making observations. Employing the antennae, a female may carefully examine the entire surface of a hip before a location on it is finally selected. When ready to oviposit, the abdomen is

elevated and strongly arched so that the caudal end is brought entirely forward, permitting the ovipositor to assume a perpendicular position between the basal abdominal region and a point on the rose hip approximately in the center (or slightly anterior of the center) of a square as defined by locations of the middle and hind tarsi. Wavering movements of the body begin at once, and after a few seconds the ovipositor sheaths are released backward, at first assuming a horizontal position, then gradually a vertical position later in the operation when the ovipositor has penetrated deeply. The more rigid ovipositor sheaths provide a means of bringing the ovipositor into the desired position and, moreover, appear to assist in the initiation of drilling by preventing the ovipositor from bending laterally, thereby facilitating greater accuracy. During the operations the wings are held in an inclined position and the antennae are porrect. Only a relatively short time is required for insertion of the ovipositor, during which time the slow wavering of the thorax, and especially of the abdomen, are conspicuous. When the ovipositor is completely inserted, the abdomen becomes more natural in shape and is brought close to, or touches the surface of the rose hip. After depositing the egg, the ovipositor is quickly withdrawn and ensheathed. The individual may then turn about to examine the puncture, but as often directly seeks another location in the series of continuous ovipositions. The time required for each of several successful ovipositions was between four and seven minutes, although some required as much as fifteen minutes. The attempts that are unsuccessful in depositing the eggs are characteristically of shorter duration.

Having made several successful egg depositions, a female may take possession of a rose hip and behave in a manner as if to guard against oviposition by others. These individuals move about excitedly with the wings elevated or inclined and make thorough examinations of the hip at varying intervals, driving away any intruding females. Occasionally the intruding female refuses to depart and a furious battle ensues, after which the intruder may be the victor and herself take possession. This most interesting behavior is especially pronounced toward the end of the oviposition period when an occasional individual, thoroughly accustomed to a particular rose hip, may persist in returning to the same location in spite of several repeated disturbances by an observer.

On warm days oviposition is seldom noted in the direct rays of the sun during hours with maximum temperature, but egg deposition is continued in the shade during this time. Females restrict much of their oviposition on such days to the early morning or late afternoon hours.

With the minimum of difficulty, females can be induced to oviposit under artificial conditions. Several branches bearing suitable hips were brought into the laboratory and placed in water vessels under bell jars near strong lights. Introduced gravid females soon began to oviposit freely as under natural conditions, and continued to do so for several days.

Adult Longevity—In order to ascertain the approximate longevity of adults in a natural environment, 188 males and 181 females were introduced into a quart jar with a fine screened cover, and this was placed in a shaded location protected from rain. Ample food supplied at all times consisted of brown

sugar solution in a cotton plug attached to the cover. Daily counts of dead specimens were recorded. The length of life under such conditions was found to be as follows: Male, minimum 1 day, maximum 14 days, average 8.45 days; female, minimum 4 days, maximum 15 days, and average 11.04 days.

The following is a tabular summarization of results obtained under various controlled laboratory conditions. For the larger lots of populations, a quart jar was used as described above. In the experiments involving smaller populations, two types of smaller containers proved very satisfactory; celluloid vials with ventilation holes, and open glass tubes. The vials were four inches long and one inch in diameter, and were kept stoppered with absorbent cotton. The glass tubes were six inches long and one inch in diameter, one end being covered with fine bolting cloth and the other stoppered with absorbent cotton. By employing these smaller containers it was possible to subject portions of the population to known constant humidities within small humidity chambers, and later to combine the data for different lots held under the same condition. The food in some earlier experiments consisted of soaked raisins fastened between the cotton stopper and a coarse cloth gauze, while in later trials the cotton stopper was saturated with brown sugar solution, and the use of raisins discontinued. Both foods appeared to suffice equally well, but the sugar solution is more convenient to use. Daily counts of dead specimens were recorded. Minimum and maximum longevity in days, as given in the following tables, do not always appear to correspond with what may be the expected, because much depends on the relative size of the lot at the time it is subjected to a given set of conditions. It is to be noted especially that data procured from small, single lots may not therefore represent the true conditions in minimum and maximum longevity (*e.g.*, Table 1, females at 15°C., and females at 30°C. and 80 per cent R.H.)

LONGEVITY OF M. NIGROVARIEGATUS IN THE LABORATORY

Under laboratory conditions where temperature fluctuated usually between 18° to 26°C., specimens supplied with food survived for an average of eight or nine days (both sexes), the maximum being about twelve days; without food, both sexes survived for an average period of three to four days, and a maximum of six days.

At lower temperatures, the duration of adult life of *M. nigrovariegatus* can be lengthened considerably. The greatest longevity at temperatures investigated was recorded for females at 15°C.; at this condition, a single female lived for a period of 87 days, which is fourteen days longer than the maximum longevity of males held at the same temperature. Relatively small proportions of the population in any lot ever approach these maxima, however. At higher temperatures, the duration of adult life of both sexes is approximately the same, though markedly reduced. It will be noted that, although at 30°C. the average longevity of both sexes is approximately the same, the maximum length of life of a relatively few males exceeds that of the females, or a reverse trend of the results at 15°C. Data obtained at 25°C. (30-60 per cent R.H.) most nearly approach those procured under natural conditions.

The continual daily emergence over a period of about a month is largely

responsible for maintenance of the normal population throughout the season of activity. When the rate of emergence noticeably decreases or ceases, the general trend in population density shows a similar course. This usually occurs sometime during the first half of July. Specimens are rarely taken during the latter part of that month, or afterwards, as is evidenced by the fact that in the large series of material examined only a single individual (♀) was captured apparently as late as September.

SEX RATIO

Sexes of this species are represented usually by nearly equal numbers. For example, of the 5,785 specimens which emerged from a single sample of rose hips, 3,088 (or 53.4 per cent) were males, and 2,697 (or 46.6 per cent) were females; based on this sample the sex ratio of females to males is 1.0 to 1.15.

PARTHENOGENETIC REPRODUCTION

A number of experiments were undertaken in which virgin females were caged on uninfested rose hips. They oviposited readily and freely, and in the late summer these hips were removed and stored at a low temperature for about a month, after which they were gradually transferred to room temperature. All specimens which emerged from these hips are males, clearly indicating that the species is capable of producing males parthenogenetically.

DEGREE OF INFESTATION AND ECONOMIC IMPORTANCE

The amount of infestation depends, for the most part, on the density of the female population at a time when rose hips are in a suitable condition for oviposition. From an infested sample, fifty hips were selected at random after emergence of the adults, and all seeds were carefully examined. Of a total of 4,283 seeds, 1,467 (or 34.3 per cent) were destroyed. Individual infested hips in this lot showed percentages ranging from 3.3 to 62.2, but of these the average infestation was 34.9 per cent. None of the rose hips examined throughout the entire study have ever been found to be 100 per cent infested, since the inner seeds are inaccessible and remain normal.

There is every indication that a systematic randomized sample, containing both infested and noninfested hips, would certainly show a much reduced percentage of infestation. This has not been ascertained but it is not likely that any figures so obtained would exceed 10 per cent, and very probably would fall within the range of 2 to 6 per cent.

M. nigrovariegatus is not recognized as an economic pest except possibly by those concerned with germination of rose seeds. Soon after rose hips have been attacked, numerous pale indentations or punctures are evident and these mark the locations of oviposition. Both growth and ripening of the infested rose fruits are interfered with to a varying degree, apparently depending on the number of seeds destroyed, and the time seed destruction occurs with reference to the age of the rose hip. Thus, it is not uncommon to find that fruits infested earlier are distinctly smaller, shriveled and somewhat off color. Such fruits usually remain on the bushes through the winter. It is question-

TABLE 1.—Temperatures constant; humidities controlled; food supplied.

Temp. ° C.	Per cent Rel. Humidity	Males				Females			
		Number	Survival in Days			Number	Survival in Days		
			Min.	Max.	Aver.		Min.	Max.	Aver.
15	30	279	2	42	18.83	17	4	43	21.24
25	30	163	1	12	9.25	236	1	17	11.42
	60	192	2	14	8.54	46	2	13	9.04
30	50	346	1	10	5.75	565	1	9	5.99
	80	133	2	9	5.41	7	4	7	5.86

TABLE 2.—Temperatures constant; without humidity control; food supplied.

Temp. ° C.	Males				Females			
	Number	Survival in Days			Number	Survival in Days		
		Min.	Max.	Aver.		Min.	Max.	Aver.
15	243	3	73	36.45	260	7	87	49.62
(1) 25	53	1	16	9.07	420	1	19	9.59
(2)	100	2	25	9.68	156	3	25	9.81
30	500	1	21	6.27	302	1	20	7.09

TABLE 3.—Temperatures constant; without humidity control; without food or water.

Temp. ° C.	Males				Females			
	Number	Survival in Days			Number	Survival in Days		
		Min.	Max.	Aver.		Min.	Max.	Aver.
15	314	2	10	5.06	101	2	11	7.65
25	156	1	3	2.28	232	1	6	2.65

able whether all such damage is due solely to this species or not. Other rose pests, such as *Rhynchities bicolor* (Fabr.) and trypetid flies of the genus *Spilographa*, also cause injury which may result in stunted, shriveled, distorted or off colored rose hips.

THE ECONOMIC IMPORTANCE OF MEGASTIGMUS

As early as 1886 and 1887, records disclose that *M. suspectus* Borr. had caused serious loss to the fir seed crop in Denmark, but the contemporary opinions involved the question whether the species was itself the pest or a parasite of another insect supposed to be the true seed destroyer. Damage to conifer seeds, due solely to a species of *Megastigmus*, was first recognized by Wachtl (1893a, 1893b). The early publication of Judeich and Nitsche (1893, 1895) and those of MacDougall (1906 *et seq.*) have stressed the economic importance of the genus in the United States. At this early date he wrote (of *M. spermotrophus* Wachtl): "The crop of seed of the Douglas spruce is sometimes entirely destroyed by a minute chalcis fly, which breeds in the seed."

The literature contains a limited amount of data on degree of infestation or destruction caused by some of the more important species. These data show considerable variation which may be due to a number of factors, *i.e.*, location, year and effect of prevailing conditions, particularly weather. Thus, Seitner (1916), Hofman (1920) and Escherich (1938) indicated that when some external factor, such as frost, reduces the seed crop, the attacks by *Megastigmus* are likely to express greater damage than in normal seed years. There is, in addition, still another very important reason for variance in published percentages of infestation; it concerns chiefly the method of collecting and analyzing the seed samples. Before a given percentage figure can be of any value as representing average damage incurred, it must come from a representative random sample. In too many instances this appears to have been overlooked and has resulted in figures of little value in summarizing the actual seed destruction over a given area.

IMPORTANT SPECIES INFESTING CONIFER SEEDS

M. spermotrophus Wachtl, a native species of western North America, is the best known because it has proved itself capable of doing much damage to seed crops of *Pseudotsuga taxifolia* (Lam.) Britt., especially in foreign countries where it has been introduced with imported seeds of its host. Its importance in Douglas fir plantations is well realized in England, particularly Scotland, and in countries of western continental Europe. It is said to have been observed in Scotland as early as 1896 (Ritchie, "Animal life in Scotland," 1920.), and by 1905 populations of outbreak proportions occurred in certain plantations (MacDougall, 1906 *et seq.*). A much publicized letter from Mr. John Crozier (MacDougall, 1906a: Crosby, 1909) referring to this outbreak indicated that during those years the crop from many older trees was destroyed to such an extent that it was not worth harvesting. Actual percentage of loss was not stated in this instance but undoubtedly it was very high. According to Laidlaw (1931), upwards of 50 per cent of the seed crop is commonly destroyed in English plantations.

In Germany, Busse (1913, 1924) observed 22 per cent infestation of seeds from fifteen "Musterbaumen" (green form of Douglas fir), while only 4 per cent was encountered in the ordinary blue Douglas fir. This author expressed the opinion that the Douglas fir seed chalcid, under ideal conditions, is capable of destroying the entire annual crop of its host. On the other hand, Escherich (1938) referred to the results of investigations conducted by the Bayerisch Forstliche Versuchsanstalt, indicating that the usual degree of infestation is much less severe; only a single case of as much as 22 per cent was encountered at that institution. Oudemans (J., 1922) and Oudemans (T., 1940a) have indicated that this species causes considerable damage in the Netherlands, and van Poeteren (1924, 1926) has also emphasized its importance. Vayssiere (1931) has called attention to it in France, and Fourage (1937) in Belgium. In New Zealand, Gourlay (1930) reported that a small sample of Douglas fir seed collected at Tapanui showed 4½ per cent infestation.

Extensive published data on the amount of damage in the United States are lacking. Our best information at present is that given by Doane et al (1936) who report that at Ashland, Oregon, in 1913, nearly 50 per cent of the Douglas fir seed crop was infested; usually, however, infestation is stated to be much lighter, or between 2 and 10 per cent. Graf von Schwerin (1912), reporting on the Prussian forests in 1910 and 1912, found that Douglas fir seed imported from America (Washington and Oregon) in 1909 and 1911 showed as much as 5 per cent infestation, with a single case of a somewhat higher per cent.

Other Important Species Infesting Conifer Seeds

M. strobilobius Ratz. is an important European species infesting seeds of *Picea excelsa* Link. Seitner (1916) was able to procure limited information on the amount of damage done in 1911 at Steiermark, Germany. During that year, which was dry, late frosts prevailed in May and June, resulting in a smaller seed crop; 50 per cent of the seeds extracted from thirty-seven cones of this crop was infested. When such factors as late frosts materially reduce the crop, such as observed by Seitner, the effect of *Megastigmus* attack is likely to be much greater. Thus, Holste (1922) noted only 3.8 per cent infestation in 1919 by the same species in material from Ober Bayern (Upper Bavaria) forest, also in Germany, indicating the possibility of entirely different ecological conditions in this location during that time. In the vicinity of Leningrad, U. S. S. R., Kurentzov (1935) reported 5.2 per cent infestation by this species under the name *abietis* Seitn.

Another European and North African species of importance is *M. suspectus* Borr. It attacks the seeds of *Abies pectinata* DC., *A. nordmanniana* Spach., *A. pinsapo* Boiss., apparently *A. sibirica* Ledeb., and also *Cedrus* sp., probably *atlantica*. Riley (1893), Judeich and Nitsche (1895) and Borries (1895) have referred to the severe damage to the seed crop in the years 1886 and 1887 on the Island of Bornholm, in Denmark. Seitner (1916) obtained three representative samples of fir seeds (total of 721 seeds), from a shipment originating in Idria (Krain, Austria); of these, 12 per cent was sound, 11

per cent infested by this species (under the name *piceae* Seitn., nec Rohwer) and 22 per cent was infested by the cecidomyiid, *Reseliella piceae* Seitn.; the remaining 55 per cent was not viable. The estimated percentage of the combined infestations by these two pests ranged from about 12 to 45 per cent. Rodd (1929), reporting on *Abies sibirica* seed in the Karpuisak Forest of the U. S. S. R., gave but 1 per cent infestation by what was probably this species under the name *strobilobius*. In a sample of 260 seeds of *A. nordmanniana*, collected in the Caucasus, Laidlaw (1931) reported 17 per cent infestation.

Very little information is available on other species which may be of equal importance. Miller (1914) pointed out that seed injury is very common to certain species of fir in the United States, whereby damage may be as high as 75 to 90 per cent. *M. pinus* Parf. and *M. rafni* Hoffm. are commonly reared from fir seed in this country and these figures may refer to either or both of these species.

According to the data supplied by Yano and Koyama (1918a) the most important of the Japanese species is *M. cryptomeriae* Yano, which infests the seeds of *Chamaecyparis obtusa* Sieb. & Zucc. and *Cryptomeria japonica* Don. The seeds of the former of these two hosts have been damaged to the extent of 94 per cent, while with seeds of the latter the percentage ranged from 3.6 to 13. Apparently of much less importance are two other species namely, *M. inamurae* Yano in the seeds of *Larix leptolepis* Murr., and *M. thuyopsis* Yano in the seeds of *Thujopsis dolobrata* Sieb. & Zucc., each of which caused only 2 per cent damage to seeds of their respective hosts.

IMPORTANT SPECIES INFESTING SEEDS OF DECIDUOUS TREES

M. pistaciae Walk. is regarded as a serious pest of pistachio in southern Europe, especially in Italy. It attacks the seeds of *Pistacia vera* L., *P. terebinthus* L. and apparently *P. lentiscus* L. and *P. mutica* L. In a series on this species under the name *M. ballestrerii* (Rond.), *De Stefani (1916-1918) disclosed that from 50 to 80 per cent of the crop on certain plantations in Sicily has been destroyed by it. The control measure recommended to combat this pest is the only practical effective remedy suggested for any destructive species of *Megastigmus*, because its use is feasible, and when rigidly employed over rather large areas there is a pronounced reduction in adult population of the pest. It consists simply in gathering and burning all infested fruits, including fallen fruits, before June or July. Infested fruits float on water while sound fruits sink, thus one can distinguish readily between them. In Sicily, this measure is carried out with respect to both *Pistacia* species that grow there (*P. vera* and *P. terebinthus*). However, female inflorescences of the turpentine tree (*P. terebinthus*) may be destroyed in April and May instead of concentrating on fallen fruits. Where the practice of destroying fruits is rigidly followed it prevents oviposition in the new crop that follows, and in some instances damage has been reduced from 80 to 20 per cent. As a matter

* The writer is tentatively accepting the recent synonymy of this species with *M. pistaciae*. Walk. by European authors. Most biological information will be found under the name *ballestrerii*.

of interest, in 1919 legislation was promulgated in Italy for the purpose of enforcing this control measure (Gaz. ufficiale del Regno d'Italia, No. 239, p. 2999; R. Staz. speriment. Agrum. Fruttic., Acireale, Boll. 37, pp. 7-10).

M. aculeatus var. *nigroflavus* Hoffm. now appears to be well established in parts of the Atlantic Seaboard. At one time it was responsible for complaints of poor germination of seeds of *Rosa multiflora* Thunb. imported from Japan. Weiss (1917) briefly stated that nearly every shipment of seeds consigned to New Jersey in 1917 was infested.

M. brevicaudis Ratz. has been responsible for the loss of a considerable portion of the fruits of certain European mountain ash trees (*Sorbus aucuparia* L.) at St. Paul, Minnesota. Beginning in early July, infested berries shrivel and drop, whereas normal berries remain on the trees until late summer and early fall. It is not unusual for as much as approximately 20 to 30 per cent of the fruits to be so affected, which is objectionable because the presence or normal fruit clusters enhances the beauty of this important ornamental shade tree.

PARASITES OF MEGASTIGMUS

The parasites of the Nearctic species of *Megastigmus* have received very little attention in the past, consequently the following discussion deals largely with the single case about which we are best informed. The fact that the vulnerable part of the cycle in the phytophagous forms of the genus is spent entirely within the seed, there is much protection offered against the attacks of parasites, except where apparently a special adaptation on the part of some other insect has made a parasitic relationship possible.

Cushman (1918) reared a species of *Megastigmus* and another belonging to *Syntomaspis* (=*Callimome*), both of which he described as new under the same name, *amelanchieris*. They were reared in company with each other from the seeds of *Amelanchier canadensis* (L) Med., and the following extract summarizes Cushman's conclusions at that time. "The result of the rearings led to the suspicion that the *Syntomaspis* was parasitic on the *Megastigmus*, and support of this idea was secured when examination of a seed from which a *Syntomaspis* had emerged disclosed an exuvium of a full-grown larva with edentate mandibles and a dead and shrivelled larva with dentate mandibles. Whether this is the normal habit of *Syntomaspis* cannot be stated definitely, but the much later emergence of the *Syntomaspis*, together with its comparative rarity and the condition of the seeds of the berries at the time the adults are active all indicate that such is the case." Regarding the habits, he stated further: "The adults of *Syntomaspis* emerge in the spring from two to three weeks later than *Megastigmus*. At this time the berries are nearly full grown, and the seeds are beginning to harden. Oviposition takes place during the latter part of June, and the insect passes the winter as a somewhat contracted larva within the seed."

Gahan (1922) referred to the habit of *C. amelanchieris* (Cush.) as "Doubtfully phytophagous. At least sometimes parasitic on *Megastigmus*." Huber (1927), in his review of the North American *Callimome*, lists the species as a parasite of *Megastigmus* sp., but says, "Mr. Cushman reports

that this species is doubtfully phytophagous, or at least it is sometimes parasitic on a species of *Megastigmus*." In the time the species has been known, no one has attempted to verify Cushman's observations or to establish definitely the entomophagous habit of *C. amelanchieris*.

Recently, Puzanova-Malysheva (1936) described in detail a "gemischter" habit belonging to a new species which was named *Syntomaspis eurytomae* (=*Callimome eurytomae* (P.-M.)), and briefly reviewed other cases of this phenomenon, which appeared to be confined to relatively few examples. During the early stages, this species is parasitic on *Eurytoma amygdali* End., and later, after consuming its host, becomes phytophagous in order to complete its development. Other examples cited by Puzanova-Malysheva were: *Eurytoma* sp., reported by Nielsen, 1906; (*Isosoma*) *Harmolita inquilinum* (R.-K.), as reported by Rimsky-Korsakov, 1914 (=*Eurytoma*?, vide Phillips, 1927); *Eurytoma parva* (Gir.), as reported by Phillips (1927); and *Callimome amelanchieris* (Cush.) was also cited because of the similarity of observations reported by Cushman (1918) with those he had made on *C. eurytomae*.

A complete historical account of the literature bearing on this interesting habit is not intended in this paper, but it should be pointed out that Phillips (1917) early mentioned the habit for *Eurytoma pater* Gir., and the same author (1918) first referred to it as occurring in *E. parva* several years before his 1927 paper. Noble (1940) has set forth the same habit in an Australian undescribed species of the genus *Eurytoma* (*Eurytoma* sp. B.). We therefore know that the "gemischter" habit is now a well established fact in a considerable number of species representing the genera *Eurytoma* and *Harmolita* of the Eurytomidae, and *Callimome* of the Callimomidae. Undoubtedly, future study will uncover more species similar to these. The reverse, *i.e.*, first phytophagous and later entomophagous, is known for a few species in *Eurytoma* and *Megastigmus* (Cf. Noble, 1940).

Being aware that the supposed parasitic habit of *C. amelanchieris* needed confirmation, and that additional observations were necessary early in the season, the writer set out to investigate this species at St. Paul, Minnesota, during the spring of 1941, in conjunction with studies on *M. amelanchieris*. To his satisfaction, he learned that the early life history of *C. amelanchieris* parallels that described for *C. eurytomae* in Europe by Pusanova-Malysheva, who had correctly surmised that such might be the case. Females of *M. amelanchieris* had oviposited in the green fruit of *Amelanchier laevis* Wieg. X. *A. humilis* Wieg. during the latter part of May, and during the first week in June most of them disappeared. The first females of *C. amelanchieris* were observed ovipositing in the same fruits on June 4, and they continued their ovipositing until the last week of that month, when only an occasional specimen was seen but no further oviposition was observed. Seed dissections were made about June 15, at which time fruits of varying sizes were selected and the contents of their seeds examined carefully. In most of the infested seeds either egg or larva of *C. amelanchieris* was found attached to a larva of *M. amelanchieris*. Parasitized host larvae were always flaccid and inactive, even those harboring the smallest parasite instar, suggesting that in the act of ovi-

positing the adult parasite might in some way be partly responsible for early inactivity of the host. Occasionally two parasites were found attached to a single *Megastigmus* larva; in one instance, one larva and the remnants of three eggs of the parasite were attached to the host. Approximately as much as 80 per cent of the larvae of *M. amelanchieris*, from the apparent second instar to at least the late third or fourth, was found to be parasitized in the infested seeds of this sample. At this time it was not uncommon to find that the parasite had already completely devoured its host and had begun to feed on the seed contents. The largest larval stage of the parasite encountered was the apparent third instar, which had finished devouring its host as well as about one-fourth of the seed content. It appears that the exact time when the phytophagous habit is assumed naturally depends almost entirely on the size of the host larva; for example, small host larvae offer sustenance for only a short time after which *C. amelanchieris* must accept contents of the seed.

Fruits exposed previously to attacks by *M. amelanchieris* were brought into the laboratory and caged with females of *C. amelanchieris*. These females oviposited freely under similar laboratory conditions as described for *M. nigrovariegatus* Ashm. Close observations, followed by subsequent dissections, demonstrated that they selected only those fruits in which *M. amelanchieris* had already oviposited, indicating the relation of the latter to oviposition response of the parasite. Each female employed the antennae to examine carefully the surface of a berry, and upon locating a desirable site proceeded to oviposit, apparently as near as possible to the puncture made by *Megastigmus*. Details of the manner of oviposition are very similar to those described for *M. nigrovariegatus*, including the occasional behavior of "guarding" the fruit by a female which had oviposited several times in a particular berry. Berries which were hard and not more than one-half grown were selected almost as readily as larger ones provided *Megastigmus* had already oviposited in them. In ovipositing, females would frequently insert and completely withdraw the ovipositor as many as five or more consecutive times in an effort to locate a host larva. Or they would partially withdraw the ovipositor and reinsert it at a different angle by twisting the abdomen to the side. This behavior suggests that the female withheld depositing the egg until her ovipositor had contacted the larva of the host. The persistence with which repeated attempts were performed until success was attained was intriguing to observe.

The fact that *C. amelanchieris* does not appear to oviposit in berries except those containing the immature stages of *M. amelanchieris*, that the eggs are deposited on the host larvae, that in all observed cases the newly hatched parasite larva fed as an external parasite and continued to do so until it had completely devoured its host, and the fact that after having done this it became phytophagous, proves without doubt that the species is one with the "gemischter" habit as described by Pusanova-Malysheva for *C. eurytomae*.

There are two other species of *Callimome* which may be found to be parasites of *Megastigmus* in much the same manner as is *C. amelanchieris*. Rodzianko (1908) reared *Syntomaspis aucupariae* Rodz. (= *Callimome aucupariae* (Rodz.)) from seeds of *Sorbus aucuparia* L. in company with *M. brevicaudis* Ratz. at Poltava, Russia. This species also has been reared along with

the same *Megastigmus* at St. Paul, Minnesota, and is strongly suspected of being a parasite in its early stages. That it is a parasite of *M. brevicaudis* in Europe has been advanced by Hoffmeyer (1930, p. 236).

Also, from the seeds of *Physocarpus opulifolius* var. *intermedius* (Rydb.) Rob. taken in Houston County, Minnesota, a new species of *Callimome* has been reared in company with both *M. physocarpi* Cy. and *M. gahani* Mill. This callimomid is likewise suspected of being a parasite on either or both of these species of *Megastigmus*.

The European literature contains the names of a rather large number of insects that are reported to be parasites of *Megastigmus*. With few possible exceptions, it is apparent that these species have not been thoroughly investigated to determine whether they are true megastigmine parasites or not.

Rondani (1877) described *Eurytoma pistaciae* as new and stated that it parasitized the larva of *M. ballestrerii* (Rond.) (=*pistaciae* Walk.). In an earlier publication (Rondani, 1876, p. 128) this eurytomid had been cited as the destroyer of a coleopterous larva.

De Stefani (1918) mentioned that he had discovered parasites of the above species of *Megastigmus* (also treated as *ballestrerii* (Rond.)) and indicated his intention of publishing on them at a later date. If such a publication has appeared making known the identity of these parasites, it has not been seen by the writer.

The following species are recorded in a part of the extensive publication of Leonardi (1927, 1928) as parasites of *Megastigmus ballestrerii* (Rond.) (= *pictaciae* Walk.) in Italy: *Decatoma strigifrons* Thoms., *D. trigocarpi* De Stef., *Eupelmus linearis* Först., *E. splendens* Gir., *Eurytoma aterrima* Schrk., *E. pistaciae* Rond., *E. rosae* Nees, *E. rufipes* Walk., *E. setigera* Mayr, *Pteromalus cupreus* Nees, *P. larvarum* (Spin.), *Syntomaspis virescens* De Stef. (=*Callimome virescens* (De Stef.)) and *Torymus nigricornis* Boh. (=*Callimome nigricornis* (Boh.)).

Boselli (1928), who compiled from literature sources between 1911 and 1925, lists the chalcid, *Eurytoma rosae* Nees, and the ichneumonid, *Mesoclistus rufipes* Grav. as parasites of the same species of *Megastigmus* in Italy.

Nikol'skaya (1934) published a list of species of Chalcidoidea which were reared in recent years in the U. S. S. R. This list contains four species as parasites of *M. pistaciae* Walk. infesting *Pistacia mutica* L., and *P. vera* L. in Kushka, Turcomania, and in the Crimea. These are as follows: *Eupelmus fulvipes* Först., *Dinarmus robustus* Masi, *Decatoma biguttata* (Swed.) and *Eurytoma setigera* Mayr. In a later paper, the same author (1935), in addition to citing *D. biguttata* and *E. setigera* as parasites of *M. pistaciae*, added *Dinarmus pistaciae* Nikol. and *Eupelmus urozonus* (Dalm.).

SUMMARY OF PARASITES

In North America to the present, only a single species, known as *Callimome amelanchieris* (Cush.), has been demonstrated to be a parasite of *Megastigmus*; its host is *M. amelanchieris* Cush., which infests the seeds of *Amelanchier* spp. and *Sorbus aucuparia* L. Other species of *Megastigmus* are

now suspected of being attacked by parasites of the genus *Callimome*, but further study of these supposed parasites is necessary before definite conclusions can be drawn.

In Europe, *M. pistaciae* Walk., which has been referred to commonly under the name *ballestrerii* (Rond.), undoubtedly is attacked by certain parasites, but details explaining the exact parasitic relationship of any one of the numerous species reputed to be its parasites appear to be lacking.

HOST INDEXES

The following indexes contain only those host records which either appear to be authentic, or those which have been confirmed by rearings subsequent to the original publication. In most instances the original publication is given as the source and authority, but in some cases this was not advisable or feasible because of the vagueness with regard to the true host. Frequently more than one citation of authority is given in order to indicate more clearly the established nature of the record. Undoubtedly, some good records have been overlooked, or they are being withheld from these indexes pending their confirmation. Additions will, therefore, have to be made as we increase our knowledge of the species. Much is yet to be learned about the hosts and habits of the Australian species of which many of the original host references are so indefinite that it would be of little value to list them here (*Cf.* Catalog of Species). In dealing with the phytophagous species, the publication of Gahan (1922) has been invaluable as a guide. The following records without citation of authority appear throughout Part I of this paper.

1. PHYTOPHAGOUS SPECIES

Abies amabilis (Dougl.) Forbes
  Megastigmus lasiocarpae Cy.
  Megastigmus pinus Parf., Crosby, 1913, p. 162.
Abies balsamea (L.) Mill.
  Megastigmus specularis Wall., Walley, 1932, p. 188.
Abies concolor Lindl. & Gord.
  Megastigmus pinus Parf., Crosby, 1913, p. 162.
  Megastigmus rafni Hoffm., Hoffmeyer, 1929, pp. 331-332.
Abies grandis Lindl.
  Megastigmus milleri Mill.
  Megastigmus pinus Parf., Hoffmeyer, 1930a, p. 215.
  Megastigmus pinus var. *marginatus* Hoffm., Hoffmeyer, 1930a, p. 216.
  Megastigmus rafni Hoffm.
Abies lasiocarpa (Hook.) Nutt.
  Megastigmus lasiocarpae Cy., Crosby, 1913, p. 163.
  Megastigmus pinus Parf.
Abies magnifica Murr.
  Megastigmus pinus Parf., Crosby, 1913, p. 162.
  Megastigmus rafni Hoffm.
Abies magnifica var. *shastensis* Lemm.
  Megastigmus milleri Mill.
  Megastigmus pinus Parf.
  Megastigmus rafni Hoffm.
Abies mariesii Mast.
  Megastigmus borriesi Cy., Crosby, 1913, p. 169.
  Megastigmus borriesi Cy., Crosby, 1913, p. 169.
Abies nobilis Lindl.
  Megastigmus pinus Parf., Crosby, 1913, p. 161.
Abies nordmanniana Spach
  Megastigmus suspectus Borr., Hoffmeyer, 1929, p. 329; 1931, pp. 264, 266.
Abies pectinata DC.
  (=*A. alba* auct.)
  Megastigmus suspectus Borr., Seitner, 1916, pp. 315, 322 (as *M. piceae* Seitn. and "Tannensamen" presumed to be *pectinata*): Hoffmeyer, 1929, p. 329; 1931, pp. 264, 266.
Abies pinsapo Boiss.

Megastigmus suspectus var. *pinsapinis* Hoffm., Hoffmeyer, 1931, p. 264.

Abies sachalinensis Mast.
Megastigmus borriesi Cy. In Serv. & Reg. Announ., U.S.D.A., Bur. Ent. & P.Q., Dec. 1940, p. 34.

Abies sibirica Ledeb.
Megastigmus suspectus Borr., Rodd, 1929, p. 154 (as *M. strobilobius* Ratz.).

Amelanchier canadensis (L.) Medic.
Megastigmus amelanchieris Cush., Cushman, 1918, p. 81.

Amelanchier laevis Wieg. X *A. humilis* Wieg. (Reciprocal)
Megastigmus amelanchieris Cush.

Amelanchier ovalis Medic.
Megastigmus brevicaudis Ratz., Seitner, 1916, p. 323: Hoffmeyer, 1931, p. 264 (*Amelanchier* sp.) [Note text].

Amelanchier sanguinea (Pursh) DC.
Megastigmus amelanchieris Cush.

Cedrus sp.
(probably *atlantica* Manetti)
Megastigmus suspectus var. *pinsapinis* Hoffm.

Chamaecyparis obtusa Sieb & Zucc.
Megastigmus cryptomeriae Yano, Yano and Koyama, 1918a, p. (38-58); 1918b, p. 375.

Cryptomeria japonica D. Don
Megastigmus cryptomeriae Yano, Yano and Koyama, 1918a, p. (38-58); 1918b, p. 373.

Cupressus sempervirens L.
Megastigmus wachtli Seitn., Seitner, 1916, pp. 321, 324.

Juniperus sp.
Megastigmus bipunctatus (Swed.).

Larix decidua Mill. (=*europae* DC.)
Megastigmus seitneri Hoffm., Hoffmeyer, 1929, p. 328.

Larix laricini (Du Roi) K. Koch
Megastigmus laricis Marc., Marcovitch, 1914, p. 435.

Larix leptolepis Murr.
Megastigmus inamurae Yano, Yano and Koyama, 1918a, p. (38-58); 1918b, p. 375.

Millettia sericea Wight & Arn.
Megastigmus leeuweni Ferr.,

Physocarpus opulifolius (L.) Maxim.
Megastigmus physocarpi Cy., Crosby, 1913, p. 158.

Physocarpus opulifolius var. *intermedius* (Rydb.) Rob.
Megastigmus gahani Mill.
Megastigmus physocarpi Cy.

Picea engelmannii (Parry) Engelm.
Megastigmus piceae Rohw., Rohwer, 1915, p. 97.

Picea excelsa Link
Megastigmus strobilobius Ratz., Seitner, 1916, pp. 309, 322 (as *M. abietis* Seitn. and "Fichtensamen" presumed to be *excelsa*): Hoffmeyer, 1929, p. 328 (as *M. abietis*).

Picea pungens Engelm.
Megastigmus piceae Rohw., Rohwer, 1915, p. 97 (*P. paryana*).

Picea sitchensis (Bong.) Carr.
Megastigmus piceae Rohw., Rohwer, 1915, pp. 97, 98.

Pinus ponderosa Laws.
Megastigmus albifrone Walk., Crosby, 1913, p. 168.

Pistacia lentiscus L.
Megastigmus pistaciae Walk., Wachtl, 1893a, p. 28; 1893b, p. 10: Nikol'skaya, 1934, p. 130.

Pistacia mutica L.
Megastigmus pistaciae Walk., Nikol'skaya, 1934, p. 130.

Pistacia terebinthus L.
Megastigmus pistaciae Walk., De Stefani, 1917, pp. 101-131 (as *M. ballestrerii* (Rond.)).

Pistacia vera L.
Megastigmus pistaciae Walk., Rondani, 1877, p. 204 (as *Trogocarpus ballestrerii* De Stefani, 1917, pp. 101-131 (as *M. ballestrerii* (Rond.)): Nikol'skaya, 1934, p. 130.

Pseudotsuga macrocarpa (Torr.) Mayr.
Megastigmus spermotrophus var. *nigrodorsatus* Mill.

Pseudotsuga taxifolia (Lam.) Britt.
Megastigmus spermotrophus Wachtl, Wachtl, 1893a, p. 25 et seq.; 1893b, p. 7 et seq.

Rosa acicularis Lindl.
Megastigmus nigrovariegatus Ashm.

Rosa alpina L.
Megastigmus aculeatus (Swed.).

Rosa blanda Ait.
Megastigmus nigrovariegatus Ashm.

Rosa californica Cham. & Schlecht.
Megastigmus nigrovariegatus Ashm.

Rosa canina L.
Megastigmus nigrovariegatus Ashm.

Rosa cinnamomea L.
Megastigmus aculeatus (Swed.), Nikol'skaya, 1934, p. 130.

Rosa davurica Pall.
Megastigmus aculeatus (Swed.).

Rosa gallica L.

Megastigmus aculeatus var. *nigroflavus* Hoffm.
Rosa jundzillii Bess.
Megastigmus aculeatus (Swed.).
Rosa kamtschatica Reg.
Megastigmus aculeatus (Swed.).
Rosa medwedewii
Megastigmus aculeatus (Swed.).
Rosa mollis Smith
Megastigmus aculeatus (Swed.).
Rosa multiflora Thunb.
Megastigmus aculeatus var. *nigroflavus* Hoffm. Weiss, 1917, p. 448 (as *M. aculeatus*): Doyer, 1925, p. 154 (as *Megastigmus* sp.): Hoffmeyer, 1929, p. 326.
Rosa palustris Marsh
Megastigmus nigrovariegatus Ashm.
Rosa rugosa Thunb.
Megastigmus nigrovariegatus Ashm., Crosby, 1913, p. 160.
Rosa sempervirens L.
Megastigmus aculeatus (Swed.). Perris, 1876, p. 222 (as *M. cynorrhodi* Perr.).
Rosa virginiana Mill.
Megastigmus nigrovariegatus Ashm.
Rosa spp.
Megastigmus aculeatus (Swed.), Wachtl, 1884, pp. 38-39 (as *M. collaris*): Crosby, 1909, pp. 378-379 (as *M. aculeatus*, in part).
Megastigmus aculeatus var. *nigroflavus* Hoffm.
Megastigmus nigrovariegatus Ashm.
Megastigmus pictus (Först.), Wachtl, 1884, p. 214.
Sorbus aucuparia L.
Megastigmus amelanchieris Cush.
Megastigmus brevicaudis Ratz., Rodzianko, 1908a, pp. 601-602, 609-611.
Sorbus sp.
Megastigmus americanus Mill., Crosby, 1909, p. 375 (as *M. brevicaudis* Ratz. and [?] *S. aucuparia*); 1913, p. 157 (as *M. brevicaudis*).
Thujopsis dolobrata Sieb. & Zucc.
Megastigmus thuyopsis Yano, Yano and Koyama, 1918a, p. (38-58); 1918b, p. 375.
Tsuga canadensis (L.) Carr.
Megastigmus hoffmeyeri Wall., Hoffmeyer, 1930a, p. 218 (as *M. spermotrophus* var. *canadensis*).
Tsuga heterophylla (Raf.) Sarg.
Megastigmus tsugae var. *heterophyllae* Mill.
Tsuga mertensiana (Bong.) Sarg.
Megastigmus tsugae Cy., Crosby, 1913, p. 162 (*T. mertensiana hookeriana*).

2. ENTOMOPHAGOUS AND PHYTOPHAGOUS SPECIES

Trichilogaster acaciae-longifoliae (Frogg.)
Megastigmus sp. B., Noble, 1940, pp. 32-35.

3. ENTOMOPHAGOUS SPECIES*

Diptera: Cecidomyiidae

Oligotrophus (?) *lyciicola* Kieff. & Jörg.
Megastigmus mendocinus Kieff. & Jörg., Kieffer and Jorgenson, 1910, p. 410.

? Family

Fly larva attacking *Helichrysum scorpioides*
Megastigmus tasmaniensis Gir., Girault, 1915b, p. 299.

Homoptera: Coccidae

Apiomorpha pileata (Schrad.)
Megastigmus iamenus Walk., Ashmead, 1901, p. 332 (*Brachyscelis*).
Apiomorpha strombylosa (Tepp.)
Megastigmus brachyscelidis Ashm., Ashmead, 1901, p. 333 (*brachyscelis crispa*).

* The term "entomophagous" as here applied must be given a loose interpretation. It is impossible to determine the true habit of all species concerned from our present knowledge, i.e., whether they are true parasites, incidental parasites, inquilines, competitors, etc.

Hymenoptera: Cynipidae

Andricus albopunctatus (Schlecht.)
Megastigmus dorsalis (Fabr.), Mayr-Fitch, 1878, p. 221.
Andricus autumnalis (Htg.)
Megastigmus dorsalis (Fabr.), Adler and Straton, 1894, p. 59.
Andricus corticis (Htg.) [?]
Megastigmus dorsalis (Fabr.), Rondani, 1876, p. 133; 1878, p. 105.
Andricus curvator (Htg.)
Megastigmus dorsalis (Fabr.), Mayr-Fitch, 1876, p. 51 (*A. curvator* var. *axillaris* (Htg.)).
Andricus cydoniae Gir.
Megastigmus dorsalis (Fabr.), Mayr, 1874, pp. 61, 136.
Andricus fecundatrix (Htg.)
Megastigmus dorsalis (Fabr.), Reinhard, 1856, p. 106 (as *Torymus*): Mayr, 1874, pp. 60, 135 (*Aphilothrix gemmae* (L.)): Adler and Straton, 1894, p. 50.
Andricus glandium Gir.
Megastigmus dorsalis (Fabr.), Perris, 1876, p. 223: Mantero, 1911, p. 93 (*Callirhytis*).
Andricus globuli (Htg.)
Megastigmus dorsalis (Fabr.), Adler and Straton, 1894, p. 42.
Andricus grossulariae Gir.
Megastigmus dorsalis (Fabr.), Mayr, 1874, pp. 61, 136.
Andricus inflator Htg.
Megastigmus dorsalis (Fabr.), Mayr. 1874, pp. 60, 135: Adler and Straton, 1894, p. 44.
Andricus lucidus (Htg.)
Megastigmus dorsalis (Fabr.), Mayr, 1874, pp. 60, 135: Fahringer, 1922, p. 46: Mantero, 1911, p. 105.
Megastigmus stigmatizans (Fabr.), Mayr, 1874, pp. 60, 132.
Andricus multiplicatus Gir.
Megastigmus dorsalis (Fabr.), Mayr, 1874, pp. 61, 135.
Megastigmus sp., Mantero, 1911, p. 97: Boselli, 1928, pp. 78, 237.
Andricus singulus Mayr
Megastigmus dorsalis (Fabr.), Mayr, 1874, pp. 60, 136 (*A. singularis* Mayr (nec Bassett)).
Andricus testaceipes Htg.
Megastigmus dorsalis (Fabr.), Adler and Straton, 1894, p. 37: Hoffmeyer, 1931, p. 265.
Andricus trilineatus Htg.
Megastigmus dorsalis (Fabr.), Mayr, 1874, pp. 60, 135 (*A. noduli*): Adler and Straton, 1894, p. 34 (*A. noduli*): Neilsen, 1902, pp. 232, 234: Hoffmeyer, 1931, p. 265.
Andricus tozae (Bosc)
Megastigmus dorsalis (Fabr.), Tavares, 1901, p. 41.
Biorhiza terminalis (Fabr.)
Megastigmus dorsalis (Fabr.), Walker, 1845, p. 849; 1846a, pp. 1454-1457 (*Teras terminalis*): Reinhard, 1856, p. 106 (as *Torymus*): Mayr, 1874, pp. 60, 135: Perris, 1876, p. 223.
Cynips argentea Htg.
Megastigmus stigmatizans (Fabr.), Walker, 1873b, pp. 279-280: Mayr, 1874, pp. 60, 132: Mayr-Walker, 1874, p. 195.
Cynips calicis Burgsd.
Megastigmus stigmatizans (Fabr.), Mayr, 1874, pp. 62, 136.
Cynips caput-medusae Htg.
Megastigmus dorsalis (Fabr.), Mayr, 1874, pp. 62, 132.
Megastigmus stigmatizans (Fabr.), Mayr, 1874, pp. 62, 136.
Cynips conglomerata Gir.
Megastigmus dorsalis (Fabr.), Mayr, 1874, pp. 60, 135.
Cynips coriaria Haimh.
Megastigmus dorsalis (Fabr.), Mayr, 1874, pp. 60, 135.
Megastigmus sp., Mantero, 1911, p. 120: Boselli, 1928, pp. 114, 237.
Cynips divisa Htg.
Megastigmus dorsalis (Fabr.), Bloesch, 1903, p. 48: Kinsey, 1930, p. 156 (*C. divisa* var. *divisa*, agamic form *divisa*).
Megastigmus stigmatizans (Fabr.), Goureau, 1867, pp. 226, 340: Rondani, 1876, p. 133; 1878, p. 108: Leonardi, 1927, p. 208; 1928, p. 31.
Cynips folii L.
Megastigmus dorsalis (Fabr.), Mayr-Fitch, 1876, p. 123 (*Dryophanta scutellaris* Htg.): Adler and Straton, 1894, p. 63 (*D. scutellaris*): Kinsey, 1930, p. 110 (*C. folii* var. *folii*, agamic form *folii*).
Cynips glutinosa Gir.
Megastigmus dorsalis (Fabr.), Mayr, 1874, pp. 60, 135 (*C. glutinosa* var. *coronata* Gir.).
Megastigmus stigmatizans (Fabr.),

Mayr, 1874, pp. 60, 132.

Cynips kollarii Htg.
Megastigmus stigmatizans (Fabr.), Mayr, 1874, pp. 60, 132: Perris, 1876, p. 223: Walker, 1876, pp. 53-59: Fitch, 1879, p. 117: Adler and Straton, 1894, p. 167.

Cynips korlevici Kieff.
Megastigmus dorsalis (Fabr.), Masi, 1919, p. 127.
Megastigmus sp., Mantero, 1911, p. 125: Boselli, 1928, pp. 114, 237.

Cynips lignicola Htg.
Megastigmus dorsalis (Fabr.), Mayr, 1874, pp. 60, 135.

Cynips longiventris Htg. ?
Megastigmus dorsalis (Fabr.), Rondani, 1876, p. 133; 1878, p. 109: Leonardi, 1927, p. 209 (as *M. dorsalis* Gour., sic!); 1928, p. 31 (do.).

Cynips mayri Kieff.
Megastigmus sp., Mantero, 1911, p. 116.

Cynips pallida (Oliv.)
Megastigmus dorsalis (Fabr.), Hoffmeyer, 1931, p. 265 (*Biorhiza pallida*).

Cynips polycera Gir.
Megastigmus dorsalis (Fabr.), Mayr, 1874, pp. 60, 135.
Megastigmus stigmatizans (Fabr.), Mantero, 1911, p. 113: Masi, 1919, p. 128: Boselli, 1928, pp. 115, 237.

Cynips tinctoriae (Oliv.)
Megastigmus dorsalis (Fabr.), Masi, 1919, p. 127 (*C. tinctoriae* var. *nostras*).
Megastigmus stigmatizans (Fabr.), Mantero, 1911, p. 123 (*C. tinctoriae* var. *nostras*): Boselli, 1928, pp. 115, 237 (*C. tinctoriae* var. *nostras*).

Neurotergus glandiformis (Gir.)
Megastigmus dorsalis (Fabr.), Mayr, 1874, pp. 62, 136 (*Spathegaster*): Mantero, 1911, p. 140.

Neurotergus lenticularis (Oliv.)
Megastigmus dorsalis (Fabr.), Ratzeburg, 1848, p. 182 (as *M. bohemanii* Ratz. on *Cynips malphigii* (Htg.)): Adler and Straton, 1894, p. 15.

Neurotergus macropterus (Htg.)
Megastigmus dorsalis (Fabr.), Mayr, 1874, pp. 60, 135 (*Dryophanta*).

Neurotergus numismalis (Oliv.)
Megastigmus stigmatizans (Fabr.), Dufour, 1847, p. 443 (as *Misocampus* on *Diplolepis reaumurii*).

Plagiotrochus kiefferianus Tav.
Megastigmus dorsalis (Fabr.), Travares, 1901, p. 49.

Synergus flavicornis Htg.
Megastigmus dorsalis (Fabr.), Fahringer, 1922, pp. 11, 46 (*S. pallicornis* Htg.).

Synophrus politus Htg.
Megastigmus dorsalis (Fabr.), Mayr, 1874, pp. 60, 135.
Megastigmus synophri Mayr, Mayr, 1874, pp. 60, 130.

Chalcidoidea: Eurytomidae

Bruchophagus mellipes Gah.
Megastigmus indi (Girault MS), Ayyar, 1920b, p. 315; 1920c, p. 935; 1925, p. 243 (as *Megastigmus* sp); Mani, 1938, p. 43.

Eurytoma fellis Gir.
Megastigmus brevivalvus (Gir.), Noble, 1933, p. 465; 1935, p. 29; 1936, pp. 38-40; 1938a, pp. 5-46.

Chalcidoidea: (?) Perilampidae

Tepperella trilineata Cam.
Megastigmus acaciae Noble, Noble, 1939, p. 266 (olim *Megastigmus* sp., 1938b, pp. 389-390; 1939, p. 236).

LIST OF NON-SPECIFIC HOSTS
(Relationship not determined)

Ficus sp. (Port Jackson Fig)
Megastigmus maculatipennis (Gir.), Girault, 1929, p. 340.

Gall (dipterous) on *Aster ramulosus*
Megastigmus asteri Ashm., Ashmead, 1901, p. 332.

Gall on *Banksia* sp.
Megastigmus banksiae (Gir.) Girault, 1929, p. 341.

Gall on *Brachychiton populneum* R. Br.
Megastigmus brachychitoni Frogg., Froggatt, 1905, p. 294.

Gall (cecidomyiid) on *Careya australis*
Neomegastigmus lividus Gir., Girault,

1915b, p. 294.

Gall (flower) on *Eucalyptus macrorryncha* F. v. M.
Megastigmus quinquesetae (Gir.) Currie, 1937, p. 171 (as a competitor of *Fergusonina* flies).

Gall on *Eucalyptus miniatus*
Megastigmus hilli Dodd, Girault, 1927, p. 331.

Gall (leaf) on *Eucalyptus obliqua*
Neomegastigmus ater Gir., Girault, 1927, p. 332.

Gall on *Eucalyptus* sp.
Megastigmus eucalypti Gir., Girault, 1915b, p. 301.

Gall (globular) on *Eucalyptus* sp.
Megastigmus iamenus Walk., Ashmead, 1901, p. 332.

Gall (flower) on Kurrajong
Megastigmus sulcicollis Cam., Cameron, 1911, p. 644.

[Gall on] Australian native lime
Megastigmus limoni (Gir.), Girault, 1926b (Priv. publ.).

ADDITIONAL COMMENTS ON HOST RECORDS

Such records involving *Spilographa alternata* Fall. (Reinhard, 1857, and subsequent authors), *Callirhytis scitula* (Bass.) (Riley, 1893), *Otiorrhynchus sensitivus* Scop. (Fuchs, 1912; Escherich, 1923), *Lestodiplosis* sp. (Escherich and Wimmer, 1903), *Malacosoma pluvialis* (Dyar) (Rühl, 1914, after Crosby, 1913, who gave *"Clisiocampa plumalis"* as the host datum appearing on a label), and several others can not be accepted. Any of the above records of supposed hosts that have appeared in the more recent literature have been copied from older sources. Several of them have been adequately disproved by later, more critical investigations: For example, von Tubeuf (1930a) has shown that the species said to be *Megastigmus* (det. Schmiedeknecht) by Escherich and Wimmer (1903) was very probably the *Tetrastichus* which he was able to rear from the same gall.

The following is a list of dubious records that should be confirmed before they are accepted. They are given here with the intent of stressing the need of further investigations.

RECORDS IN NEED OF CONFIRMATION

Abies arizonica Merr.
Megastigmus piceae Rohw., Hoffmeyer, 1930a, p. 215.

Eucalyptus sp.
Megastigmus ballestrerii (Rond.) (= *pistaciae* Walk.) Reh, 1932, p. 387: Escherich, 1938, p. 366.

Evonymus sp.
Megastigmus aculeatus (Swed.).

Picea sitchensis (Bong.) Carr.
Megastigmus pinus Parf., Hoffmeyer, 1930, p. 215.

Pinus sylvestris L.
Megastigmus pinus Parf., von Tubeuf, 1930a, p. 526 (Probably not based on reared material. Cf. Escherich, 1938, p. 375).

Pseudotsuga taxifolia (Lam.) Britt.
Megastigmus rafni Hoffm., Hoffmeyer, 1929, p. 332.

Rhamnus sp.
Megastigmus aculeatus (Swed.).

Tsuga sp.
Megastigmus pinus Parf., Gahan, 1922, pp. 40, 54.

Diptera: Cecidomyiidae

Mikiola fagi (Htg.)
Megastigmus dorsalis (Fabr.), Coulon, 1931, p. 76.

Lepidoptera: Gelechiidae

Dichomeris marginella (Fabr.)
Megastigmus bipunctatus (Swed.), Mayr, 1874, pp. 63, 139 (*Hypsolophus*).

Pyralididae

Mineola vaccinii (Rly.)
Megastigmus brevicaudis Ratz., Franklin, 1916, p. 42.

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PLATE 1

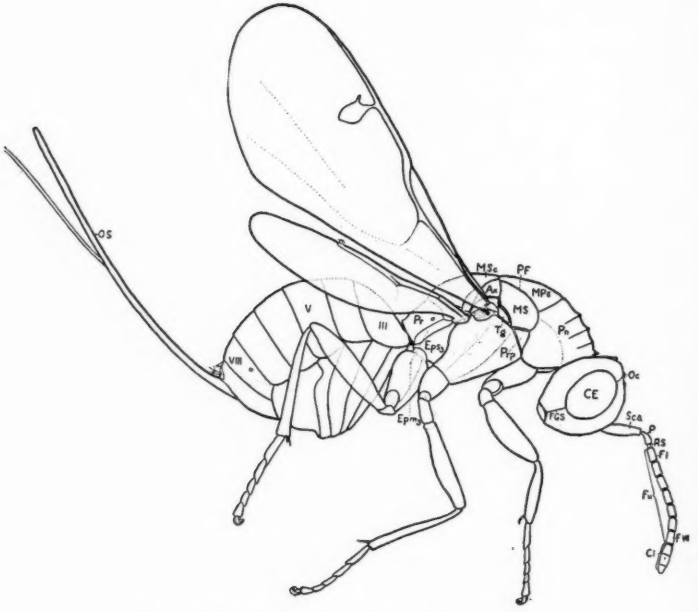
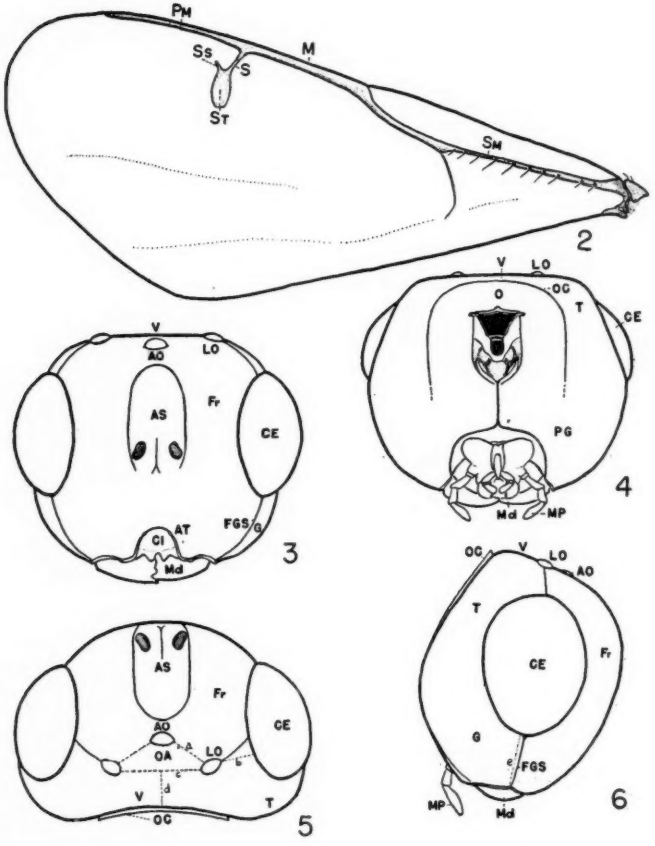


Fig. 1.—*Megastigmus nigrovariegatus* Ashm. (Female)

Abbreviations: *Ax*, axilla; *CE*, compound eye; *Cl*, club; *Emp3*, metepimeron; *Eps3*, metepisternum; *FGS*, fronto-genal suture; *Fu*, funicle; *Fl-VII*, segments of the funicle; *MPs*, mesopraescutum; *MS*, mesoscutum; *MSc*, mesoscutellum (or scutellum); *Oc*, ocellus; *OS*, ovipositor sheath; *P*, pedicel; *PF*, parapsidal furrow; *Pn*, pronotum; *Pr*, propodeum; *Prp*, prepectus; *RS*, ring segment; *Sca*, scape; *Tg*, tegula; *III*, *V*, *VIII*, segments of the abdomen.

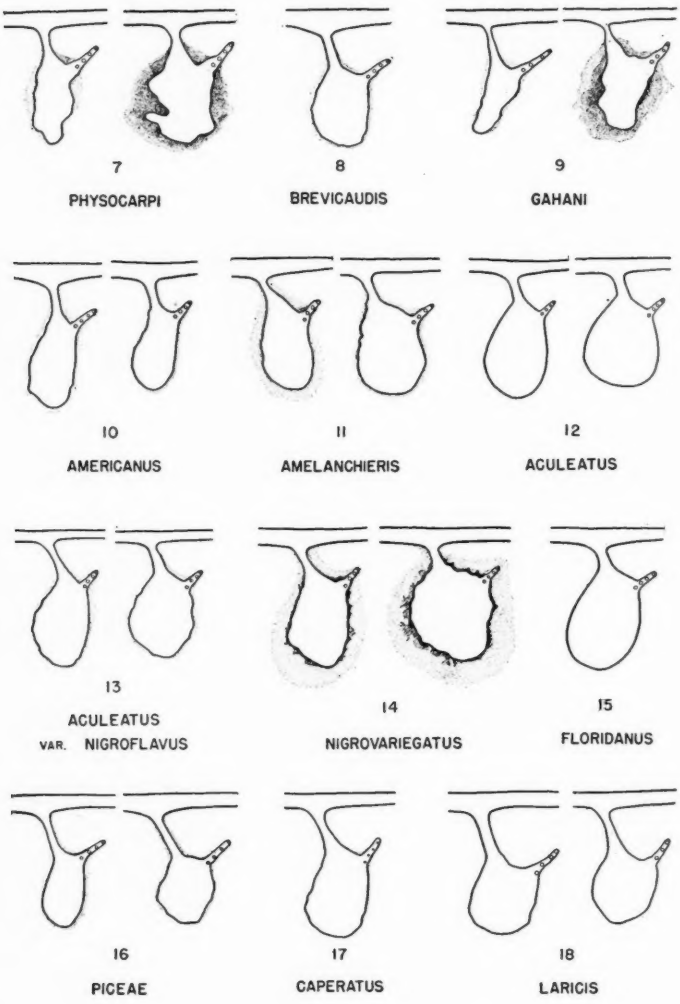
PLATE 2



Figs. 2-6.—2. Front wing (*M. spermotrophus* Wachtl); 3. Anterior aspect of the head (*M. nigrovariegatus* Ashm.); 4. Posterior aspect of the head (*M. nigrovariegatus* Ashm.); 5. Dorsal aspect of the head (*M. nigrovariegatus* Ashm.); 6. Lateral aspect of the head (*M. nigrovariegatus* Ashm.).

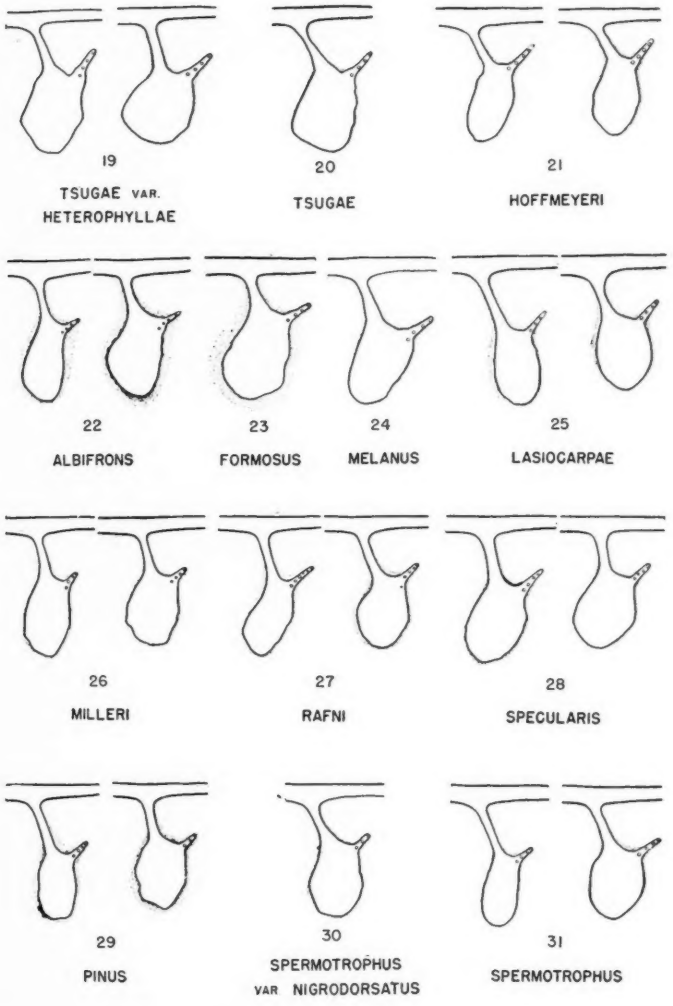
Abbreviations: *AO*, anterior ocellus; *AS*, antennal scrobe; *AT*, anterior tentorial pit; *CE*, compound eye; *Cl*, clypeus; *FGS*, fronto-genal suture; *Fr*, front; *G*, gena; *LO*, lateral ocellus; *M*, marginal vein; *Md*, mandible; *MP*, maxillary palp; *O*, occiput; *OA*, ocellar area; *OC*, occipital carina; *PG*, postgena; *Pm*, postmarginal vein; *S*, stigmal vein; *Sm*, submarginal vein; *Ss*, stigmal sector; *St*, stigma; *T*, temple; *V*, vertex; *a*, lateral ocellar line; *b*, ocellocular line; *c*, posterior ocellar line; *d*, ocelloccipital line; *e*, malar space (length).

PLATE 3



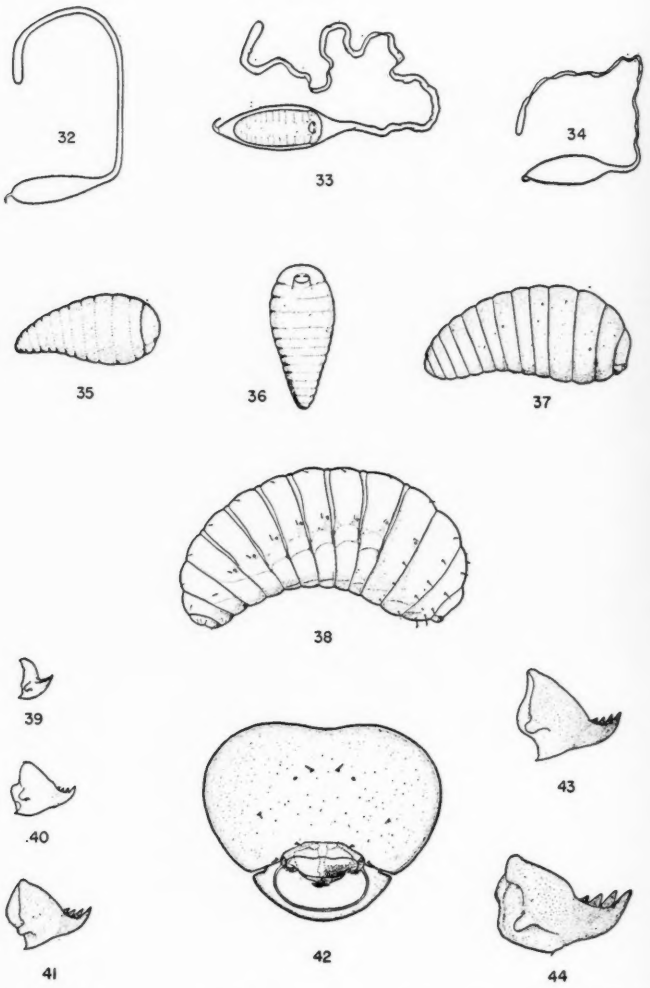
Figures 7-18.—Stigmata of Nearctic species of *Megastigmus*.

PLATE 4



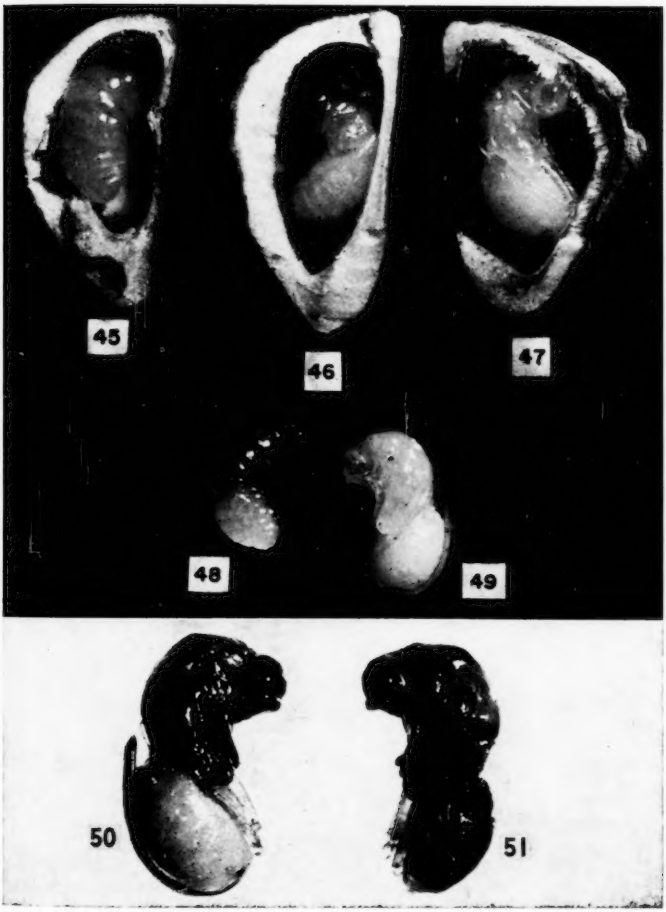
Figures 19-34.—Stigmata of Nearctic species of *Megastigmus*.

PLATE 5



Figs. 32-44. Immature stages of *M. nigrovariegatus* Ashm.—32. Ovarian egg; 33. Egg containing late embryo; 34. Egg after deposition; 35. First instar larva, lateral aspect; 36. First instar larva, ventral aspect; 37. Third instar larva; 38. Fifth instar larva; 39. Mandible of first instar larva; 40. Mandible of second instar larva; 41. Mandible of third instar larva; 42. Head of fifth instar larva, anterior aspect; 43. Mandible of fourth instar larva; 44. Mandible of fifth instar larva.

PLATE 6



Figs. 45-51. Immature stages of *M. nigrovariegatus* Ashm.—45. Full-grown larva within the seed, natural position; 46. Prepupa within the seed, natural position. Note excrement pellets; 47. Newly transformed, female pupa within the seed, natural position. Note excrement pellets; 48. Full-grown larva removed from the seed; 49. Newly transformed, female pupa removed from the seed; 50. Female pupa shortly before transforming to the adult; 51. Male pupa shortly before transforming to the adult.

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Distribution of Leptorhynchoides thecatus, a Common Acanthocephalan Parastic in Fishes

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One of the commonest forms met in the parasitic fauna of the ceca and small intestine of fresh water fishes of eastern North America is the acanthocephalan, *Leptorhynchoides thecatus* (Linton, 1891) (31). The frequency with which this helminth is met in laboratory and field and the attempts to regard it as either a new species or a new genus have prompted the preparation of this analysis of its hosts and geographical distribution with the view that the assembled records might prove useful to investigators interested in various aspects of the ecological relationships of fishes and their parasites.

The writers have been particularly impressed by the wide geographical distribution of this species and the exceptional plasticity of its adaptations to hosts of extremely diverse taxonomic status. Preliminary to the present study, detailed morphological studies were conducted on materials from different parts of the geographical range. At first it seemed possible that more than one species might have been confused under a single name since specimens from Canadian hosts showed fairly consistent differences from those taken farther south in number as well as in length and breadth of the proboscis hooks. On final analysis these differences were regarded as representing but normal individual variability. In the light of these studies and interpretations, the species has been redefined in a separate paper (Lincicome and Van Cleave, 29) as a contribution toward a fuller understanding of *Leptorhynchoides thecatus*.

Acknowledgements

The writers are indebted to numerous colleagues for the loan of collections for study and for making available unpublished as well as published records of the occurrence of *L. thecatus*. Specific acknowledgment of many of these collaborators is offered in the descriptive paper mentioned above (29) and will not be repeated here. To Dr. Reeve M. Bailey, Curator of Fishes of the University of Michigan Museum of Zoology, we are especially indebted for assistance in checking the names of fish hosts.

Presentation of Data

In a study such as is here presented for *L. thecatus* the names of hosts, localities from which recorded and sources of the records are all significant.

For convenience of reference all of this information is collated as a single table (Table I). In the life of this parasite at least four distinct groups of animals are involved as potential hosts: fishes, amphibians, reptiles, and arthropods. Of these, fishes and arthropods are essential links in the life cycle while the amphibians and reptiles seem to be chiefly accidental hosts. In Table I, the specific names are listed alphabetically for each of the host groups. A common name in parentheses follows the name of each host. For the fishes, most of the scientific names are those adopted by Hubbs and Lagler (20), while the common names are those recommended by the Committee on Common and Scientific Names of Fishes of the American Fisheries Society (1). An asterisk indicates that the worm has been reported as an encysted form in the mesenteries or as immature in the gut, while "M" signifies that the parasite has been taken from the lumen of the intestine of the host. Although most of the species so marked shelter sexually mature adult worms, in some instances the parasite is able to be maintained although it cannot attain functional maturity. In the present listing, no attempt has been made to differentiate between normal and accidental host species.

Many records of hosts and localities are here included for the first time. Thus the present list is more than a compilation from the literature. Previously unrecorded hosts and localities from the collections of the writers are referred to as citations under bibliographic references 28 and 47. Geographical locations are cited for each host together with one or more numbers to indicate the appropriate reference or authority in the bibliography.

For many of the literature references there has been no sure means of checking the validity of host determinations, especially the names of subspecies. The extreme adaptability of *L. thecatus* makes this shortcoming of less significance than might be true for any species of parasite having marked host specificity. It is the writers' belief that in an area where *L. thecatus* is established and the normal larval host (*Hyalella*) is present, a complete host list might ultimately include every species of fish which regularly or accidentally feeds upon *Hyalella* or upon fishes which carry juveniles of *L. thecatus* encysted in the viscera. Consequently, expanded host lists are in a manner misleading since many of the recorded species are accidental hosts incapable of bringing the parasite to reproductive maturity and not essential for passing the immature worms on to a proper definitive host.

TABLE I.—Geographical list of hosts of *Leptorhynchoides thecatus*.

A. FISH HOSTS

1. *Ambloplites rupestris* (Rock bass) *M

Great Lakes 18	Lake Erie 10	New York 21, 44, 48
Illinois 39	Massachusetts 32	Ontario 28
Indiana 47	Michigan 40, 47	Wisconsin 9, 13, 17, 34, 47

2. *Ameiurus melas melas* (Northern black bullhead) *M

Lake Erie 10	Ohio 8	Wisconsin 9, 17
Michigan 47	Tennessee 11	

3. *Ameiurus natalis natalis* (Yellow bullhead) *M

New York 48	Ohio 8	Wisconsin 17

4. *Ameiurus nebulosus nebulosus* (Brown bullhead) *M
Connecticut 22 Minnesota 47 Ontario 6
Massachusetts 32 New York 21, 47, 48 Tennessee 11
Michigan 47 Ohio 8 Wisconsin 9, 17, 47

5. *Ameiurus nebulosus marmoratus* (Marbled brown bullhead) *M
Florida 7

6. *Amia calva* (Bowfin) *M
Florida 7 Lake Erie 10 Ohio 52
Great Lakes 18 Michigan 47 Tennessee 11
Illinois 39 Minnesota 47 Wisconsin 17, 34, 47

7. *Anguilla bostoniensis* (American eel) *M
Massachusetts 26 New York 42, 47, 48 Tennessee 11
Minnesota 47 Ontario 6 Wisconsin 34

8. *Aplodinotus grunniens* (Freshwater drum) *M
Lake Erie 10 Tennessee 11 Wisconsin 34
Minnesota 47

9. *Boleosoma nigrum* (Johnny darter) M
Minnesota 47 Wisconsin 34

10. *Boleosoma nigrum nigrum* (Central Johnny darter) *M
Wisconsin 17

11. *Boleosoma nigrum olmstedi* (Tessellated Johnny darter) M
New York 48

12. *Carpiodes carpio* (River carpsucker) M
Illinois 39

13. *Catonotus flabellaris lineolatus* (Striped fantail) *M
Wisconsin 17

14. *Catostomus commersonnii* (White sucker) *M
Connecticut 22 Ohio 8 Wisconsin 17, 34, 47
Michigan 40

15. *Chaenobryttus coronarius* (Warmouth) *M
Florida 5 Ohio 19 Tennessee 11, 50

16. *Coregonus clupeaformis* (Lake whitefish) M
Ontario, 6, 12

17. *Cristivomer namaycush* (Lake trout) M
Ontario 12, 33

18. *Cyprinus carpio* (Carp) M
Illinois 39 Lake Erie 10

19. *Enneacanthus gloriosus* (Blue spotted sunfish) M
Florida 5

20. *Erimyzon sucetta sucetta* (Eastern lake chubsucker) M
Florida 7

21. *Esox lucius* (Pike) M
Michigan 40 New York 48 Wisconsin 9, 17, 47
Minnesota 47 Ontario 28

22. *Esox masquinongy masquinongy* (Great Lakes muskellunge) M
Ontario 47 Wisconsin 9

23. *Esox niger* (Chain pickerel) M
Connecticut 22, 25 Wisconsin 47

24. *Esox vermiculatus* (Grass pickerel) *M
Ohio 8

25. *Fundulus chrysotus* (Golden topminnow) *
Florida 7 Tennessee 11

26. *Fundulus diaphanus menona* (Western banded killifish) M
Minnesota 47 Wisconsin 34

27. *Fundulus dispar* (Starhead topminnow) *
Tennessee 11

28. *Fundulus grandis* (Gulf killifish) *
Florida 7

29. *Fundulus majalis* (Striped killifish) *
Florida 7

30. *Fundulus notatus* (Northern starhead topminnow) *M
Ohio 8 Tennessee 11 Wisconsin 34

31. *Fundulus similis* (Longnose killifish) *
Florida 7

32. *Gambusia affinis* (Mosquito fish) *
Tennessee 11

33. *Gambusia affinis holbrooki* (Eastern gambusia) *
Florida 7

34. *Hadropterus maculatus* (Blacksided darter) M
Wisconsin 17

35. *Hiodon tergisus* (Mooneye) M
Illinois 39

36. *Huro salmoides* (Largemouth black bass) *M
Connecticut 22 Michigan 40 Ohio 3, 8, 19
Florida 5 Minnesota 47 Tennessee 11, 49
Illinois 39 New York 21, 24 Wisconsin 9, 17, 34, 47
Lake Erie 10

37. *Hybopsis storerianus* (Silver chub) M
Lake Erie 10

38. *Ictiobus bubalis* (Smallmouth buffalo) M
Illinois 39

39. *Ictalurus lacustris punctatus* (Channel catfish) *M
Florida 7 Minnesota 47 Tennessee 11
Illinois 39 Ohio 8 Wisconsin 34
Lake Erie 10

40. *Lepibema chrysops* (White bass) M
New York 48 Tennessee 11 Wisconsin 47
Ohio 8

41. *Lepisosteus osseus* (Longnose gar) M
Lake Erie 10 Wisconsin 34

42. *Lepisosteus platostomus* (Shortnose gar) M
Illinois 39 Tennessee 11

43. *Lepisosteus platyrhincus* (Florida gar) *
Florida 7

44. *Lepomis auritus* (Yellowbelly sunfish) M?
New York 21

45. *Lepomis cyanellus* (Green sunfish) *
Ohio 8

46. *Lepomis gibbosus* (Pumpkinseed) *M
Connecticut 22 Lake Erie 10 Ohio 8, 19
Illinois 39 Minnesota 47 Ontario 6, 12, 28
Iowa 47 New York 21, 48 Wisconsin 7, 9, 17, 34, 47

47. *Lepomis humilis* (Orangespotted sunfish) *
Tennessee 11

48. *Lepomis macrochirus* (Bluegill) *M
Florida 5 Lake Erie 10 Ohio 8, 19
Illinois 39, 47 Minnesota 47 Wisconsin 9, 17, 34, 47
Iowa 47

49. *Lepomis megalotis* (Longear sunfish) *M
Iowa 47 Ohio 8

50. *Lepomis microlophus* (Redear sunfish) *M
Florida 5 Tennessee 11

51. *Lepomis punctatus miniatus* (Western spotted sunfish) *
Tennessee 11

52. *Lepomis punctatus punctatus* (Eastern spotted sunfish) *M
Florida 5

53. *Lota lota maculosa* (Burbot) *M
Michigan 47 Ohio 47, 52 Wisconsin 9
New York 48 Ontario 6, 12

54. *Microperca proeliaris* (Cypress darter) *
Tennessee 11

55. *Micropterus dolomieu* (Smallmouth blackbass) *M
Connecticut 22 Lake Erie 10 New York 21, 23, 24, 47
Great Lakes 18 Massachusetts 32 Ohio 3, 8
Illinois 39 Michigan 40, 47 Ontario 6, 12, 28, 47
Indiana 47 Minnesota 47 Wisconsin 9, 13, 17, 34, 47

56. *Micropterus punctulatus* (Spotted black bass) M
Ohio 4

57. *Morone americana* (White perch) M
Connecticut 22 Massachusetts 32 New York 7, 31, 39

58. *Morone interrupta* (Yellow bass) M
Tennessee 11

59. *Moxostoma rubreques* (Greater redhorse) *
Wisconsin 17

60. *Nocomis biguttatus* (Hornyhead chub) M
Wisconsin 17

61. *Noturus flavus* (Stonecat) *M
Lake Erie 10 New York 48 Wisconsin 17

62. *Opsopoeodus emiliae* (Pugnose minnow) *
Florida 7

63. *Pilodictus olivaris* (Flathead catfish) M
Tennessee 11 Minnesota 47

64. *Perca flavescens* (Yellow perch) *M
Connecticut 22 Michigan 40, 47 Ohio 8
Illinois 39 Minnesota 47 Ontario 6, 12, 28
Iowa 47 New York 21, 48 Wisconsin 9, 13, 17, 34, 47
Lake Erie 10

65. *Percina caprodes* (Logperch) *M
Lake Erie 10 Michigan 40, 47 Ohio 8

66. *Percopsis omiscomaycus* (Trout-perch) *
Lake Erie 10

67. *Poecilichthys caeruleus* (Rainbow darter) *
Ohio 8 Wisconsin 17

68. *Poecilichthys exilis* (Iowa darter) *M
Lake Erie 10 Ohio 8 Wisconsin 17

69. *Pomoxis annularis* (White crappie) *M
Illinois 39 Ohio 8 Wisconsin 34

70. *Pomoxis nigro-maculatus* (Black crappie) *M
Florida 5 Lake Erie 10 Tennessee 11
Illinois 39, 47 Minnesota 47 Wisconsin 9, 17
Iowa 47

71. *Prosopium cylindraceum quadrilaterale* (Round whitefish) M
Tennessee 11

72. *Salmo gairdnerii* (Rainbow trout) M
Tennessee 11

73. *Salvelinus fontinalis fontinalis* (Common brook trout) *M
Ontario 12 Wisconsin 9

74. *Schilbeodes mollis* (Madtom) *M
Minnesota 47 Ohio 8 Wisconsin 17, 34

75. *Semotilus atromaculatus atromaculatus* (Northern creek chub) *M
Wisconsin 17

76. *Stizostedion canadense* (Sauger) M
Minnesota 47 Wisconsin 34

77. *Stizostedion vitreum* (Pike perch) *M
Lake Erie 10 Ontario 28, 47 Wisconsin 9, 17, 34, 47
New York 21, 43

78. *Stizostedion vitreum glaucum* (Blue pike perch) *
Lake Erie 10

79. *Umbra limi* (Central mudminnow) *M
Wisconsin 17

B. AMPHIBIAN HOSTS

80. *Amphiuma tridactylum* (Three toed Congo eel) M
Tennessee 38, 47

81. *Necturus maculosus* (Mud puppy) M
Indiana 47

C. REPTILIAN HOSTS

82. *Drymarchon corais couperi* (Gopher snake) M
District of Columbia Zoo 47 (source unrecorded)

83. *Natrix sipedon* (Common water snake) M
New York 47 Ohio 2, 47

D. ARTHROPOD HOST

84. *Hyalella azteca* (Amphipod) Larvae
Michigan 14, 15 Minnesota 41

COMMENTS

The long list of vertebrates which serve as the definitive host for *Leptorhynchoides thecatus* demonstrates a very wide latitude in physiological adaptation between this parasite and its hosts. This species reaches maximum size and seems to find optimal conditions in a relatively small number of fishes of which the most important seem to be the largemouth and smallmouth black bass (*Huro salmoides* and *Micropterus dolomieu*), the yellow perch (*Perca flavescens*) and possibly the rock bass (*Ambloplites rupestris*). Many of the species of fishes and all of the amphibians and reptiles which have been recorded as hosts seem to have acquired the host relationship accidentally. In many of these the worm is able to maintain itself at least temporarily although in some it has never been found in a state of functional maturity. The studies of Van Cleave (41) and of De Giusti (14, 15, 16) on the life history of *L. thecatus* have shown that a common amphipod, *Hyalella azteca*, serves as the essential host for hatching the eggs and developing the larvae. The widespread use of amphipods as food for fish and the broad geographical distribution of *Hyalella* are important factors in explaining the wide dispersal of *L. thecatus*. Conditions during the development within the amphipod explain the frequent occurrence of encysted young worms in the viscera of normal definitive hosts. De Giusti has shown that young worms less than thirty days of age in the amphipod do not remain in the fish intestine but even in appropriate fish hosts they leave the intestine and become encysted in the mesenteries. Cannibalism and predacious habits, so common among game fishes especially, are the only avenues for juvenile worms encysted in the viscera of fishes to reenter the digestive tract where they may complete their developmental cycle. Larvae which have developed 30 days or more in the amphipod host are infective juveniles capable of attaching immediately to the mucosa of the intestine and the gastric ceca of any suitable fish which devours the infected amphipod.

The geographical range for many species of parasites having two or more

obligatory hosts is often set by the area of coincidence of distribution of the definitive and the larval hosts. However this is not always true and it fails entirely in explaining the distribution of *L. thecatus*.

In spite of the fact that numerous species of fish serve *L. thecatus* as definitive host, there have been no records of finding this parasite in parts of the range of several of its important definitive hosts. Doubtless, in many regions this may be attributed to lack of field studies. *Hyalella*, the larval host of *L. thecatus*, is reputed by several authorities to be abunant throughout the United States and even extends into Central America. Thus the very general distribution of its larval host and the broad composite distribution of the definitive host species presage a potential distribution for *L. thecatus* of much greater extent than is recorded in the present study. The factors responsible for the species failing to attain the dispersal limits set by its hosts have not been resolved.

The distribution of *L. thecatus*, as now understood, is considerably greater than was recorded by earlier writers. Van Cleave (46) 1931 regarded it as "restricted to Northeastern United States and Southeastern Canada." At that time no results of surveys of fish parasites were available for any state south of Illinois. Bangham (5, 7) and Venard (49, 50) and these two men working together (11) have conducted surveys in Tennessee and in Florida and similar extensive studies have become available for other parts of the country. As a result of these surveys *L. thecatus* is now known from thirteen of the United States and from the Canadian province of Ontario. In the United States it is recorded from New England to Florida on the Eastern Seaboard and westward through the Ohio valley to the Mississipi drainage from the west. Except for instances in Iowa and Minnesota there are no recorded findings of this worm west of the Mississippi, and it is probable that in these frontier states the scattered records represent inadequate sampling of a general dispersion through the streams emptying into the Mississippi River.

Little is known regarding the parasites of hybrid fishes. At least theoretically some species of parasitic worms with high host specificity offer an opportunity for the study of transmission of susceptibility. Bangham (9) has recorded the occurrence of *L. thecatus* in a cross between a northern pike and a muskellunge in Wisconsin. Since both of the species entering the cross are normal hosts of *L. thecatus* it is not surprising that their offspring should acquire the same species of parasite.

DELETION OF EXTRALIMITAL RECORDS

Dr. Gwendolyn Rees (37) reported finding *L. thecatus* in fishes of rock pools along the coast of Wales. She kindly submitted some of her specimens to one of us (D. R. L.) for study. These individuals had 16 to 18 longitudinal rows of proboscis hooks with 10 hooks in each row while in *L. thecatus* there are but 12 longitudinal rows of from 13 to 16 hooks each. Furthermore, the prominent cuticular thecae which envelope the hooks of *L. thecatus* are entirely lacking. From these observations it is obvious that

the specimens had been incorrectly identified, in fact they seem to represent some species of the genus *Echinorhynchus* although specific determination has not been attempted. Consequently, Wales and Great Britain must be stricken from the list of localities from which *Leptorhynchoides thecatus* has been obtained and at the same time *Cottus bubalis* and *Onos mustelus* which Dr. Rees cited as hosts must be deleted from the host list for *L. thecatus*.

SUMMARY

1. Data on hosts and geographical distribution of *Leptorhynchoides thecatus* are summarized from the literature and previously unrecorded hosts and distribution records from the authors' files are included.

2. Seventy-nine species of fish, two reptiles, two amphibians and one amphipod are recorded as hosts for *L. thecatus*. The amphibians and reptiles are regarded as accidental hosts. The amphipod is host to the developing young. The fishes listed include both normal definitive hosts and accidental infections although no attempt has been made to distinguish between these two types of relationship in the present paper.

3. Eleven states (including nine east of the Mississippi River, Iowa and Minnesota) and the Canadian province of Ontario constitute the known geographical range of this species. Possibly other states in the Mississippi drainage may ultimately be added to this list. Since neither positive nor negative records are available for many areas, it seems probable that *L. thecatus* may be continuously distributed over its range in habitats where suitable intermediate and definitive hosts are present.

4. Suitable definitive hosts and larval hosts are much more widely distributed than the known distribution of *L. thecatus*. Factors responsible for the restriction of the distribution of this parasite have not been resolved.

5. The occurrence of *L. thecatus* in a hybrid cross between a great northern pike and a muskallunge is not surprising since both of the parent species are normal hosts of this parasite.

6. Records of *L. thecatus* from *Cottus bubalis* and *Onos mustelus* of the fauna of Wales are deleted from the distribution and host records on the basis of examination of some of the original material which seems to be an undetermined species of *Echinorhynchus*.

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An Additional Trematode from Tortugas, Florida, and a New Name for Opisthoporus Manter, 1947, Preoccupied*

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Professor José M. Ruiz of Sao Paulo, Brazil, has kindly called my attention to the fact that the generic name *Opisthoporus* Manter, 1947 had been used several times previously, a condition which I had indeed checked but thoughtlessly forgot. For *Opisthoporus* Manter, 1947 (nec *Opisthoporus* Benson, 1851; *Opisthoporus* Minot, 1877; *Opisthoporus* Fukui, 1929), the name *Postporus* is proposed. The two species become *Postporus epinepheli* (Manter, 1947) and *Postporus mycteropercae* (Manter, 1947).

The combination *Pleurogonius candidulus* (Linton, 1910) (misspelled "*candibulus*" in my paper) had been made in 1946 by Ruiz (1946: 295) where, however, it was first printed "*candulus*". Its correct name is, therefore, *Pleurogonius candidulus* (Linton, 1910) Ruiz, 1946.

The author's report on trematodes of marine fishes of Tortugas, Florida (Manter, 1947) refers (p. 258) to a few species not described because they were represented by single specimens deemed inadequate for satisfactory identification. One of these has since been studied in the light of Dollfus' (1946) description of some interesting trematodes from *Kyphosus sectatrix* from Dakar, Africa. It is a spiny distome from a related host (*Kyphosus incisor*) and is closely related to *Cadentella cadenati* (Dollfus, 1946) Nagaty, 1948.

As Nagaty (1948) has noted, *Enenterum pseudaureum* Dollfus, 1946 from *Kyphosus sectatrix* at Dakar, Africa is a synonym of *Enenterum pimelepteri* Nagaty, 1942 from "*Pimelopterus tahmel*" in the Red Sea. The host genus *Pimelepterus* Lacapède, 1802 is listed as a synonym of *Kyphosus* by Jordan, Evermann and Clark (1930). Nagaty's spelling "*pimelopteri*" seems to be from "*Pimelopterus*" of Schinz, 1822 apparently a misspelling of *Pimelepterus*.

Cadenatella americana n. sp.

Fig. 1

Host.—*Kyphosus incisor* (Cuv. & Val.), yellow chub; in 1 of 5 hosts examined.
Location.—Intestine.

Description (based on a single specimen).—Body elongate, muscular, considerably contracted; length 3.367 mm.; greatest width 0.628 mm.; almost equally wide along most of length; spined anteriorly with numerous scales which extend only to acetabular level on dorsal surface but to level of ovary (almost to midbody) on ventral surface. Oral sucker completely retracted into anterior end of body, with 8 lobes. Lobes not very distinct but seemingly

* Studies from the Department of Zoology, University of Nebraska, No. 235.

absent directly ventral to mouth; transverse diameter of oral sucker 0.234 mm. Acetabulum 0.234 mm. in transverse diameter, 0.583 mm. from anterior end of body with the forebody somewhat contracted; sucker ratio 1:1. Ventral accessory sucker present opposite basal portion of pharynx; embedded in body; 0.087 mm. in diameter. Prepharynx short but with lateral outfoldings perhaps resulting from contraction of body; probably never longer than pharynx; pharynx large, 0.219 mm. in length, 0.204 mm. in width; esophagus very short or lacking; ceca reaching to near posterior end of body where they unite and open through a conspicuous, dorsal, subterminal pore. The excretory vesicle seems to open through the same pore but this point could not be certain from the totomount.

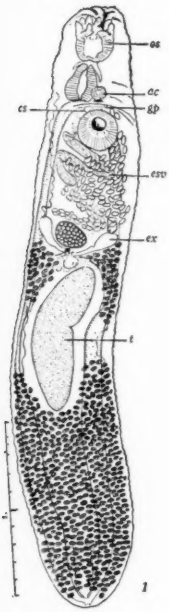

Fig. 1.—Ventral view of *Cadenatella americana*. Made with the aid of a camera lucida. The projected scale has a value of 1. mm. Abbreviations: *ac*, accessory sucker; *cs*, cirrus sac; *esv*, external seminal vesicle; *ex*, excretory vessel, swollen terminal portion; *gp*, genital pore; *os*, oral sucker; *t*, testis.

Genital pore slightly to the left near anterior border of acetabulum. Testis single, elongate, slightly indented on one side near its middle; located near middle of hindbody; length 0.824 mm., width 0.255 mm.; posttesticular space 1.095 mm. Cirrus sac thin-walled, small and very inconspicuous; extending from genital pore almost horizontally to the right along anterior edge of acetabulum; pyriform; 0.153 mm. long by 0.058 mm. wide; containing a few prostatic cells; pars prostatica extending along right margin of acetabulum; prostatic cells free in parenchyma; seminal vesicle external, immediately postacetabular; tubular; with two loops, one extending to the left cecum, the second reaching to the right cecum; posterior end of vesicle about halfway between acetabulum and ovary. Ovary ovoid, 0.088 mm. anterior to testis; seminal receptacle probably represented by a small spherical vesicle just posterior to ovary, but it is empty of sperm cells and its connections are not clear; Mehlis' gland at anterior border of ovary; sperm cells in early coils of uterus; uterus preovarian. Vitelline follicles beginning at posterior edge of ovary; ventral, dorsal and lateral to ceca, confluent but not ventrally between testis and ovary; interrupted opposite middle half of testis; filling most of posttesticular space; confluent posterior to testis. Eggs thin-shelled; 61 to 66 by 32 to 34 μ.

Excretory vesicle extending to a point midway between ovary and testis where it receives two, much swollen arms or branches which extend diagonally forward to level of anterior border of ovary. While the appearance is that of a Y-shaped vesicle, the short arms are probably enlarged regions of lateral vessels. A pair of sinuous vessels extends along at least most of the body length. A uroproct is probably present but very short.

Comparisons.—The only other species in the genus is *Cadenatella cadenati* Dollfus, 1946. Dollfus' material was somewhat macerated being collected after death of the host, and my material is limited to a single specimen. Therefore, more adequate material might show the two species to be identical. At present certain differences seem evident. *C. americana* is smaller (3.367 mm. as compared with 7 mm.) yet the accessory sucker is much larger (0.087 mm. as compared with 0.064 mm.); its eggs are 61 to 66 μ long as compared with 70 μ; an external seminal vesicle is not described for *C. cadenati*. *C. americana* has a shorter prepharynx, longer testis, and shorter posttesticular space. Dollfus did not observe the anus or the excretory system. *Enenterum aureum* has an I-shaped excretory vesicle which extends well anterior to the ovary dorsal to the uterus.

Discussion.—*Kyphosus* is a fish genus of unusual interest as a host. Its parasites tend to be distinctive and unusual. At Tortugas, Florida, *Kyphosus sectatrix* and *K. incisor* share four species of digenetic trematodes. *Cadenatella americana* was collected only from *K. incisor* but more examinations would probably show it could occur in *K. sectatrix*. Of the genera of trematodes involved, only *Haplosplanchnus* is known from other hosts. The following table lists the known parasites of *Kyphosus* and their localities.

Species	Locality	Reference
TREMATODA		
Cadenatella cadenati	Dakar, Africa	Dollfus, 1946
Deontacylix ovalis	Tortugas, Fla.	Linton, 1910, Manter, 1947
Enenterum aureum	Tortugas, Fla.	Linton, 1910, Manter, 1947
Enenterum pimelepteri	Red Sea; Dakar, Africa	Nagaty, 1942; Dollfus, 1946
Haplosplanchnus acutus	American Pacific	Manter, 1940
Haplosplanchnus kyphosi	Tortugas, Fla.	Manter, 1947
Jeancadenatia brumpti	Dakar, Africa	Dollfus, 1946
Koseiria tahmeli	Red Sea	Nagaty, 1942
Opisthadena dimidia	Tortugas, Fla.	Linton, 1910; Manter, 1947
ACANTHOCEPHALA		
Filisoma bucerium	Pacific Coast of Mexico	Van Cleave, 1940
Filisoma fidum	Tortugas, Fla.	Van Cleave & Manter, 1948

Four of the 9 species of trematodes are in the genus *Enenterum* or in related genera. The genus *Enenterum* occurs in the Red Sea, along the west coast of Africa, and in the Gulf of Mexico. *Cadenatella* occurs in the latter two regions. *Enenterum pimelepteri* apparently occurs in the Red Sea and the African Atlantic, but species of *Enenterum* and *Cadenatella* in American waters seem to have differentiated from Old World species. Unfortunately, sufficient trematodes from Pacific species of *Kyphosus* have not been collected. Two species of Acanthocephala are known from related species of *Kyphosus* in the Atlantic and Pacific. VanCleave and Manter (1948) state "speciation within the genus *Kyphosus* has apparently been accompanied by speciation of the Acanthocephalan parasites in species of the hosts which are at present widely separated geographically from each other." Similar phenomena are known among parasites of land animals.

In view of the peculiar trematodes characteristic of *Kyphosus* species, it will be of interest to know the parasitic fauna of the various species of *Kyphosus* distributed throughout Oceania where at least 8 species occur. It is to be hoped that when such specialists as ichthyologists, herpetologists and ornithologists accompany expeditions to the more remote regions of the earth, parasitologists can also be in attendance to collect the helminths and other parasites. The helminths of fishes of Oceania constitute a large, unexplored field. My collection records from Tortugas in the Gulf of Mexico, and from the Pacific coast of tropical America indicate that the number of species of digenetic trematodes is approximately 80% of the number of species of fishes. According to Fowler (1938) there are about 1800 species of fishes known from Oceania. If the variety of trematodes there is similar to what it is in the warm seas of the New World, some 1400 species of trematodes await collection there. Other unexplored areas are those of southern Atlantic waters and, in fact, most of the Southern Hemisphere.

The type specimen of *Cadenatella americana* is deposited in the Helminthological Collection of the United States National Museum.

SUMMARY

1. The generic name *Postporus* is offered for *Opisthoporus* Manter, 1947, preoccupied.

2. *Cadenatella americana*, from *Kyphosus incisor*, is described as a new species.

3. A list of the helminth parasites of *Kyphosus* is given with notes on their geographical distribution.

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A Survey of the Shore-Line Fauna of the Norfolk Peninsula

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This paper is a preliminary list and commentary upon the occurrence of animal organisms identified[1] from the waters and shore-lines of Norfolk, Virginia, and surrounding territory. The commonly known fresh-water forms such as the Protozoa are not included. Some of the collecting records date from 1931.

Geologically, the Norfolk Peninsula is a low-lying area with an altitude of from two to six feet. Its shore lines are very irregular, being indented by numerous estuaries and creeks. Hampton Roads proper is bounded generally by relatively narrow sandy beaches with occasional swampy areas. Wharves and break-waters are plentiful for the study of vertical distributions of sessile forms. The waters are mostly salty or brackish, fresh-water being scarce. The soil has a sand base, particles of which are of medium coarseness. The color varies but is never completely white. The slope of the beaches is quite shallow.

Five principal stations have served as foci in the collection of material. Poquoson Flats was chosen as an off-shore open sea station. Here, at the mouth of the Roads, specimens were taken by dredging from the oyster beds. Hampton Bar, located at the confluence of Hampton Creek with the Roads, served as a station subject to strong tidal action.

Willoughby Bay was used to exemplify a quiet rather shallow protected area. The Craney Island (Elizabeth River) station receives much industrial and domestic pollution and is subjected to an almost constant program of channel dredging. The Bolling Ave. (Edgewater) station is located on the Elizabeth River near a large sewer outlet. It was marked by sluggish tidal action, very shallow waters and a rubble strewn strand. In general these stations are typical of the Norfolk area, with the exception of the open sea-side beach. The Lynnhaven Inlet region has a combniation of open sea beaches and creeks subject to tidal action. Lafayette River is a relatively sluggish brackish creek with many branches productive of mud-flats and swamps.

The methods of collecting were adapted to the habitat being studied. Material was gathered from shore and shallow waters by hand, using dip and

1 The authors express their appreciation for the invaluable assistance of Dr. Waldo L. Schmitt and his co-workers at the U. S. National Museum in the identification of many of the organisms.

plankton nets of various kinds, while an oyster dredge was used in deeper places. Smaller material was sorted into white enamel buckets and allowed to stand in the water in which it was taken until most of the organisms congregated at the surface to be gathered by forceps or pipette. The Pearse techniques for the collection of sand beach forms were followed at the Bolling Ave. station. This included large and fine mesh sand seivings, spading to a depth of three feet, salve box plankton studies, salimeter readings and temperatures taken above and two inches below sand level. Insects were taken above the high tide mark in the tidal rubble. A few of the fishes taken from the shallows of the Bolling Ave. station are appended to the check list.

Persons interested in mosquito distribution throughout Virginia are referred to the valuable work of Dorer, Bickley and Nicholson (1944) which is considered as quite complete. The present collection of mosquitoes has been supplemented by that work.

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Annotated Check List of the Aquatic and Shore-Line Fauna of the Norfolk Peninsula

Phylum PORIFERA Grant 1835

Class NONCALCAREA Vosmaer 1887

Order TETRAXONIDA Dendy 1905

Cliona celata Grant.—Dredged from Poquoson Flats off Hampton Roads (marine) and Lynnhaven Inlet, Virginia Beach (marine)

Reniera tubifera George and Wilson.—Shallows of Edgewater, Norfolk, at low water (brackish)

Chalina oculata (Pallas).—Dredged from Poquoson Flats off Hampton Roads (marine) and Lynnhaven Inlet, Virginia Beach (marine)

Chalina arbuscula Verrill.—Dredged from Poquoson Flats off Hampton Roads (marine) and Lynnhaven Inlet, Virginia Beach (marine)

Stylotella heliophilia H. V. Wilson.—Shallows of Edgewater, Norfolk, at low water (brackish)

Phylum COELENTERATA Leuckart 1847

Class HYDROZOA Huxley 1857

Order TUBULARIAE

Hydractinia echinata Fleming.—Common on shells and piling, Norfolk (marine and brackish) and Lynnhaven Inlet, Virginia Beach (marine)
Podocoryne sp.—Elizabeth River, Norfolk (brackish)
Tubularia crocea (Ag.).—On piling in shallow water, Norfolk (brackish)
Sertularia sp.—On seaweed at low water, Norfolk (brackish)
Thuiaria argentia (L.).—Dredged from Willoughby Bay, Ocean View (marine and brackish)
Schizotricha sp.—Shallows of Hampton Roads area (brackish)
Obelia sp.—In seaweed at low water, Willoughby Bay, Ocean View (marine)

Class SCYPHOZOA Grobben 1910

Order SEMAEOSTOMEAE L. Agassiz 1862

Dactylometra quinquecirrha.—Elizabeth River, Norfolk (brackish)
Cyanea sp.—Elizabeth River, Norfolk (brackish)

Class ANTHOZOA Ehrenberg 1834

Order ALCYONARIA Milne-Edwards and Haime 1857

Leptogorgia hebes Verrill.—Hampton Roads area (marine and brackish)

Order ZOANTHARIA Blainville 1830

Sagartia luciae Verrill.—Common on shells and piling in shallow water, Hampton Roads area (marine and brackish)
Sagartia leucolena Verrill.—Common on shells and piling in shallow water, Hampton Roads area (marine and brackish)
Astrangia danae Agassiz.—Cape Henry (marine)

Phylum CTENOPHORA Hatschek 1889

Class TENTACULATA Wagner 1834

Order LOBATA Eschscholtz 1829

Mnemiopsis leidy A. Agassiz.—Abundant at times, Hampton Roads open water (marine)
Mnemiopsis gardeni Agassiz.—Abundant at times, Hampton Roads open water (marine)

Class NUDA Bourne 1900

Order BEROIDEA Eschscholtz 1929

Beroe ovata Chamisso and Eysenhardt.—Abundant at times, Hampton Roads open water (marine)

Phylum PLATYHELMINTHES Gegenbaur 1859

Class TURBELLARIA Ehrenberg 1831

Order ACOELA Bresslau 1933

Childia spinosa.—Shallows of Lafayette River, Norfolk (brackish)
Aphanostoma sp.—Shallows of Lafayette River, Norfolk (brackish)
Monochoerus sp.—Shallows of Lafayette River, Norfolk (brackish)

Order RHABDOCOELA Bresslau 1933

Catenula sp.—Roadside ditches and ponds, Norfolk area (fresh)
Stenostomum sp.—Common in streams and ponds of Norfolk area (fresh)
Rhynchoscolex sp.—Common in streams and ponds of Norfolk area (fresh)
Microstomum sp.—Norfolk Golf Course Ponds (fresh)
Macrostomum beaufortensis Ferguson.—Shallows of Lafayette River, Norfolk (brackish)
Omalostomum schultzei.—Shallows of estuaries, Norfolk (brackish)
Prorhynchus sp.—Roadside ditches, Great Dismal Swamp (fresh)

Vejdovskya sp.—Shallows of Lafayette River, Norfolk (brackish)
Baicallelia sp.—Lake Smith, Norfolk County (fresh)
Dalyellia sp.—Norfolk Golf Course ponds (fresh)
Jensenia lewisi Jones and Ferguson.—Shallows of Lafayette River, Norfolk (brackish)
Proxenetes sp.—Shallows of Lafayette River, Norfolk (brackish)
Mesostoma sp.—Roadside ditches, Great Dismal Swamp (fresh)
Trigonostomum sp.—Shallows of Lafayette River, Norfolk (brackish)
Tauridella sp.—Ocean shallows, Seaside State Park, Norfolk (marine)
Phonorhynchus pearsei Stirewalt, Ferguson and Kepner.—Shallows of Lafayette River, Norfolk (brackish)
Gyratrix hermaphroditus.—Common in ponds of Norfolk area (fresh)
Karkinorhynchus sp.—Shallows of Lafayette River, Norfolk (brackish)

Order ALLOEOCOELA Bresslau 1933

Cylindrostomum triste (Graff.)—Shallows of Lafayette River, Norfolk (brackish)
Enterostomula graffi (Beauchamp).—Shallows of Lafayette River, Norfolk (brackish)
Plagiostomum wilsoni Graff.—Shallows of Lafayette River, Norfolk (brackish)
Monocelis sp.—Shallows of Lafayette River, Norfolk (brackish)
Archiloa wilsoni Kepner, Stirewalt and Ferguson.—Shallows of Lafayette River, Norfolk (brackish)

Order TRICLADIDA Bresslau 1933

Euplana gracilis (Girard).—Ponds of South Norfolk (fresh) and algal masses, Willoughby Bay, Ocean View (marine)

Order POLYCLADIDA Bresslau 1933

Stylochus ellipticus (Girard).—Shallows of Lafayette River, Norfolk (brackish)

Phylum NEMERTEA Cuvier 1815

Order HETERONEMERTEA Bürger 1892

Micrura leidyi (Verrill).—Sands of Lynnhaven Inlet, Virginia Beach (marine) and Newport News (marine) at low water

Order HOPLONEMERTEA Hubrecht 1879

Zygonemertes virescens (Verrill).—Elizabeth River, Norfolk, beaches at low water (brackish)
Tetrastemma sp.—Elizabeth River, Norfolk, beaches at low water (brackish)
Oerstedia dorsalis (Abildgaard).—On piling at low water, Norfolk (marine)

Phylum NEMATODA Rudolphi 1808

Order MONHYSTERINA Chitwood 1937

Suborder MONHYSTERATA Filipjev 1929

Axonolamus sp.—Sands and algae of Edgewater, Norfolk (brackish)
Monhystera sp.—Sands and algae of Edgewater, Norfolk (brackish)

Order CHROMODORINA Chitwood 1937

Prochomodora oryeli.—Sands and algae of Edgewater, Norfolk (brackish)
Chromodorita sp.—Sands and algae of Edgewater, Norfolk (brackish)

Order ENOPLINA Chitwood 1937

Oncholaimus sp.—Sands and algae of Edgewater, Norfolk (brackish)

Phylum BRYOZOA Ehrenberg 1831

Class ECTOPROCTA Nitsche 1869

Order GYMNOLAEMATA Allman 1856

Membranipora sp.—Edgewater, Norfolk at low water (brackish)
Hemiseptella denticulata Smith.—Breakwater at Little Creek (marine)

Bugula sp.—Dredged from Willoughby Bay, Ocean View (marine and brackish)
Schizoporella sp.—Edgewater, Norfolk, at low water (brackish)
Lepralia (Cryptosula) sp.—Breakwater at Little Creek (marine)
Alcyonidium hirsutum (Fleming).—On algae of Lynnhaven Inlet, Virginia Beach (marine)
Amathia dichotoma.—Edgewater, Norfolk, at low water (brackish)

Phylum ANNELIDA Lamarck 1809

Class ARCHIANNELIDA Hatschek 1878

Dinophilus gardineri A. Moore.—Abundant at times in isolated mud-flats of Lafayette River, Norfolk (brackish)

Class POLYCHAETA Grube 1850

Order POLYCHAETA ERRANTIA Audouin and Edwards 1832

Lepidonotus sublevis Verrill.—Sands of Lynnhaven Inlet, Virginia Beach (marine)
Eteone alba Webster.—Mussel beds near Craney Island, Norfolk (brackish)
Autolytus sp.—Dredged at Willoughby Bay, Ocean View (marine and brackish)
Nereis culveri Webster.—Common in sands of Edgewater, Norfolk (brackish), Little Creek (marine) and Lafayette River (brackish)
Nereis limbata Ehlers.—Common in sands of Lynnhaven Inlet, Virginia Beach (marine), Little Creek (marine) and Lafayette River (brackish)
Nereis pelagica L.—Common in sands of Lynnhaven Inlet, Virginia Beach (marine), Little Creek (marine) and Lafayette River (brackish)
Namanereis sp.—Shallows of Lynnhaven Inlet, Virginia Beach (brackish)
Neanthes succinea (Frey and Leukart).—Edgewater, Norfolk at low water (brackish)
Nephthys bucera Ehlers.—Breakwater sands of Lafayette River (brackish) and Little Creek (marine)
Diopatra cuprea (Bosc).—Edgewater, Norfolk at low water (brackish), Lynnhaven Inlet, Virginia Beach and Little Creek (marine)
Marphysa leidyi Quatr.—Shallows of Lynnhaven Inlet, Virginia Beach (brackish) and Little Creek (marine)
Lumbrinereis sp.—Silty areas of Elizabeth River, Norfolk (brackish)
Arabella opalina (Verrill).—Backwater inlets of Lafayette River, Norfolk (brackish) and Lynnhaven Inlet, Virginia Beach (marine)
Glycera dibranchiata Ehlers.—Edgewater, Norfolk, at low water (brackish) Lynnhaven Inlet, Virginia Beach (marine) and Little Creek (marine)

Order POLYCHAETA SEDENTARIA Audouin and Edwards 1832

Scoloplos robustus (Verrill).—Edgewater, Norfolk at low water (brackish)
Scoloplos fragilis (Verrill).—Edgewater, Norfolk at low water (brackish)
Spio setosa Verrill.—Common at Edgewater, Norfolk at low water (brackish) Lynnhaven Inlet, Virginia Beach (marine) and Little Creek (marine)
Laonice viridis Verrill.—Edgewater, Norfolk at low water (brackish)
Amphitrite ornata (Leidy).—Lafayette River, Norfolk at low water (brackish), Lynnhaven Inlet, Virginia Beach (marine) and Little Creek (marine)
Thelepus cincinnatus (Fabricius).—Lynnhaven Inlet, Virginia Beach at low water (marine)
Polycirrus eximius (Leidy).—Edgewater, Norfolk at low water (brackish)
Enoplobranchus sanguineus Verrill.—Shallows of Lafayette River, Norfolk (brackish) and Lynnhaven Inlet, Virginia Beach (marine)
Cistenides gouldi (Verrill).—Edgewater, Norfolk at low water (brackish)
Notomastus filiformis Verrill.—Backwaters of Lafayette River, Norfolk (brackish)
Clemenella torquata Leidy.—Shallows of Lafayette, Norfolk (brackish)
Arenicola cristata Stimpson.—Edgewater, Norfolk at low water (brackish)
Hydroides hexagonus Bosc.—Common in Hampton Roads area (brackish and marine)
Sabella crassicornus Sars.—Edgewater, Norfolk at low water (brackish)
Spirorbis sp.—Common at Edgewater, Norfolk at low water (brackish) and Newport News (marine)

Class HIRUDINEA Lamarck 1818

Order RHYNCHOBDELLIDA Blanchard 1887

Piscicola punctata (Verrill).—Shallows of York River, Yorktown (brackish)
Cystobranchus vividus Verrill.—Dredgings from Willoughby Bay, Ocean View (marine and brackish)

Phylum ARTHROPODA Siebold and Stannius 1845

Class CRUSTACEA Pennant 1777

Order COPEPODA Latreille 1831

Harpacticus chelifer O. F. Müller.—Algal dredgings from Willoughby Bay, Ocean View (marine)
Harpacticus gracilis Claus.—Algal dredgings from Willoughby Bay, Ocean View marine)

Order OSTRACODA Latreille 1802

Loxoconcha granulata Sars.—Shallows of Edgewater beaches, Norfolk, in algae (brackish)
Loxoconcha parallela G. W. Müller.—Shallows of Edgewater beaches, Norfolk, in algae (brackish)

Order CIRREPEDIA Burmeister 1844

Lepas anitifera L.—On marine construction in Hampton Roads (marine)
Balanus balanoides (L.).—Abundant in intertidal zone, Hampton Roads area (marine)
Balanus eburneus Gould.—Abundant in intertidal zone, Hampton Roads area (marine)
Chthalamus fragilis Darwin.—Lynnhaven Inlet, Virginia Beach at low water (marine) and Newport News (marine)

Order AMPHIPODA Latreille 1817

Orchestia platensis Kröyer.—Beachline rubble at Lynnhaven Inlet, Virginia Beach (marine)
Orchestia grillus (Bosc).—Beachline rubble at Lynnhaven Inlet, Virginia Beach (marine)
Talorchestia longicornus (Say).—Common and nocturnal in intertidal zone at Edgewater, Norfolk (brackish)
Haustorius arenarius (Slabber).—Sands of Lynnhaven Inlet, Virginia Beach toward open sea (marine)
Gammarus sp.—Common in algal dredgings in Hampton Roads area (marine and brackish)
Melita fresnilli Audouin.—Beachline at Edgewater, Norfolk (brackish)
Melita nitida Smith.—Beachline at Edgewater, Norfolk (brackish)
Carinogammarus mucronatus (Say).—Shallows of Elizabeth River, Norfolk (brackish)
Batea catharinensis Müller.—Abundant in intertidal zone, Hampton Roads area (marine)
Elasmopus sp.—Shoreline of Lafayette River, Norfolk (brackish)
Arctopontius expansus G. O. Sars.—Intertidal zone at Edgewater, Norfolk (brackish)
Amphithoë valida Smith.—In algal masses from Willoughby Bay, Ocean View (marine)
Amphithoë longimana Smith.—In algal masses from Willoughby Bay, Ocean View (marine)
Amphithoë rubricata (Montagu).—In algal masses from Willoughby Bay, Ocean View (marine)
Amphithoë sp.—Intertidal zone, Edgewater, Norfolk (brackish)
Grubia compta Smith.—Intertidal zone, Edgewater, Norfolk (brackish)
Corophium acherusicum Costa.—Dredgings from Willoughby Bay, Ocean View (marine and brackish)
Corophium tuberculatum Shoemaker.—Dredgings from Willoughby Bay, Ocean View (marine and brackish)

Caprella acutifrons Latreille.—Common in shallows of Lynnhaven Inlet, Virginia Beach (marine)
Paracaprella simplex Mayer.—Shallows of Elizabeth River, Norfolk (brackish)
Erichthonius brasiliensis (Dana).—Shallows of Elizabeth River, Norfolk (brackish)
Aeginella longicornis Kröyer.—Algal masses from Willoughby Bay, Ocean View and Newport News (marine)

Order ISOPODA Latreille 1817

Exophaeroma sp.—Lynnhaven Inlet, Virginia Beach (marine)
Sphaeroma quadridentatum Say.—Common in intertidal rubble at Edgewater, Norfolk (brackish)
Idothea baltica (Pallas).—Common in algal masses from Willoughby Bay, Ocean View (marine and brackish)
Chirodotea caecao (Say).—Little Creek (marine) and Lynnhaven Inlet, Virginia Beach (marine)
Edotea triloba (Say).—Shorelines of Lafayette River, Norfolk (brackish)
Edotea sp.—Shorelines of Lafayette River, Norfolk (brackish)
Erichsonella attenuata (Harg.)—Shallows of Lafayette River, Norfolk (brackish)
Armadillidium vulgare (Latreille).—In rubble above tidal line at Edgewater, Norfolk (brackish)
Scyphacella arenicola Smith.—Dredgings from Willoughby Bay, Ocean View (marine)
Ligyda exotica (Roux).—Shallows of Lafayette River, Norfolk (brackish), mud-flats of Little Creek (brackish) and Lynnhaven Inlet, Virginia Beach (marine)

Order DECAPODA Latreille 1802

Crago septemspinosus (Say).—Dredgings from Willoughby Bay, Ocean View (marine)
Palaemonetes vulgaris (Say).—Lynnhaven Inlet, Virginia Beach (marine)
Palaemonetes carolinus Stimpson.—Common in algal dredgings and net catches from Willoughby Bay, Ocean View (marine and brackish)
Homarus americanus Milne-Edwards.—Reportedly taken off Hampton Roads (marine)
Pagurus longicarpus Say.—Common in shallows of Lynnhaven Inlet, Virginia Beach (marine) and Newport News (marine)
Pagurus pollicaris Say.—Abundant in Hampton Roads area (marine)
Emerita talpoida (Say).—Abundant at times on beachlines of Lynnhaven Inlet, Virginia Beach (marine)
Libinia emarginata Leach.—Common on Hampton Bar oyster beds (marine)
Libinia dubia Milne-Edwards.—Common on Hampton Bar oyster beds (marine)
Libinia erinacea Milne-Edwards.—Common on Hampton Bar oyster beds (marine)
Neopanope texana Smith.—Common in dredgings and sponge masses, Hampton Roads area (marine)
Rithropanopeus harrisi (Gould).—Dredgings from Willoughby Bay, Ocean View (marine and brackish)
Eurypanopeus depressus (Smith).—Dredgings from Willoughby Bay, Ocean View (marine and brackish)
Callinectes sapidus Rathbun.—Shallows of Hampton Roads area (marine)
Ovalipes ocellatus (Herbst).—Common in shallows of Lynnhaven Inlet, Virginia Beach (marine) and Newport News (marine)
Sesarma cinereum (Bosc).—Dredgings from Willoughby Bay, Ocean View (marine)
Pinnotheres ostreum Say.—Common in oysters of Hampton Roads (marine)
Ocypode albicans Bosc.—Beaches of Lynnhaven Inlet, Virginia Beach
Uca pugnax (S. I. Smith).—Abundant in backwater mud-flats of Lafayette River, Norfolk (brackish)

Class INSECTA Linnaeus 1758

Order ORTHOPTERA Latreille 1796

Phaneroptera curvicauda DeG.—Beach line rubble at Edgewater, Norfolk
Paroxya clavuliger (Serv.).—Beach-line rubble at Edgewater, Norfolk
Melanoplus femur-rubrum (DeG.).—Beach-line rubble at Edgewater, Norfolk

Trimerotropis maritima maritima Harris.—Beach-line rubble at Edgewater, Norfolk
Schistocerca alutacea (Harris).—Beach-line rubble at Edgewater, Norfolk
Gryllus assimilis (F.)—Beach-line rubble at Edgewater, Norfolk
Leptysma marginicollis (Serv.).—Beach-line rubble at Edgewater, Norfolk

Order HEMIPTERA

Anasa tristis DeG.—Beach-line rubble at Edgewater, Norfolk
Arilus cristatus L.—Beach-line rubble at Edgewater, Norfolk
Euryophthalmus succinctus (L.)—Beach-line rubble at Edgewater, Norfolk.
Hesperoleon abdominalis (Say).—Beach-line rubble at Edgewater, Norfolk
Pselliopus cinctus (F.).—Beach-line rubble at Edgewater, Norfolk

Order COLEOPTERA Linnaeus 1758

Tetracha carolina L.—Beach-line rubble at Edgewater, Norfolk
Brachynus sp.—Beach-line rubble at Edgewater, Norfolk
Harpalus faunus (Say).—Beach-line rubble at Edgewater, Norfolk.
Harpalus pennsylvanicus (DeG.).—Beach-line rubble at Edgewater, Norfolk
Notoxus delicatus Cas.—Beach-line rubble at Edgewater, Norfolk
Schoenicus puberlus Lec.—Beach-line rubble at Edgewater, Norfolk
Calendra setiger Chttn.—Beach-line rubble at Edgewater, Norfolk

Order LEPIDOPTERA Linnaeus 1758

Nodonata clypealis.—Beach-line rubble at Edgewater, Norfolk
Mesogramma polita (Say).—Beach-line rubble at Edgewater, Norfolk

Order DIPTERA Linnaeus 1758

Aedes aegypti (L.).—Common in domestic containers of Southeast
Aedes atlanticus D. and K.—Shady temporary rain pools, fairly common
Aedes canadensis (Theob.).—Woods swamps, fairly common
Aedes cantator (Coq.).—Rare in salt marshes, found at Camp Peary; other records not definite
Aedes dupreei (Coq.)—Temporary rain puddles, rare at Lake Drummond, Dismal Swamp and Camp Peary
Aedes fulvus pallens Ross.—"Rare. Single female from light trap, Camp Pendleton, June 21, 1943, H. P. Nicholson."
Aedes mitchellae (Dyar).—Rainwater pools, fairly common in Hampton Roads area
Aedes sollicitans (Walker).—Common in salt marshes of Norfolk Peninsula
Aedes taeniorhynchus (Wied.).—Salt marshes, common
Aedes triseriatus (Say).—Tree holes, fairly common
Aedes vexans (Meig.).—Flood waters, common
Anopheles atropos D. and K.—Rare, from salt marshes, Onley, Eastern Shore
Anopheles bradleyi King.—Common in brackish water, Hampton Roads area
Anopheles crucians Wied.—Permanent fresh water with vegetation, common in Hampton Roads area
Anopheles barberi Coq.—Tree holes and tin cans in woods, rare in Princess Anne County
Anopheles quadrimaculatus (Say).—Extremely rare in open fresh water pools near Norfolk, common elsewhere in Southeast
Anopheles walkeri Theob.—Rare in fresh water marshes, Cape Henry, near Norfolk
Culex apicalis Adams.—Common in fresh water swamps
Culex erraticus D. and K.—Common in fresh water swamps and ponds with duckweed
Culex peccator D. and K.—Rare in fresh water swamps, Camp Peary
Culex pipiens L.—Common in polluted fresh waters
Culex quinquefasciatus (Say). Rare in domestic containers and polluted ground water, Norfolk
Culex restuans Theob.—Common in polluted fresh water ditches
Culex salinarius Coq.—Common in grassy pools of either fresh or brackish water
Culiseta inornata (Will.).—Fairly common in permanent fresh water ponds

Culiseta melanura (Coq.).—Fairly common in permanent fresh water ponds
Mansonia perturbans (Walk.).—Fairly ocmmon in fresh water marshes with aquatic vegetation
Megarhinus septentrionalis D. and K.—Rare in tree holes and rock holes
Orthopodomyia signifera (Coq.)—Rare, taken in tree holes and rain barrels, Hampton Roads area and northern Virginia
Psorophora ciliata (F.).—Fairly common in temporary rain pools
Psorophora confinnis (L. and A.).—Fairly common in temporary rain pools
Psorophora ferox (Humb.).—Fairly common in temporary rain pools
Psorophora howardii (Coq.).—Fairly common in temporary rain pools
Psorophora varipes (Coq.).—Fairly common in temporary rain pools
Uranotaenia sapphirina (O. and S.).—Common in fresh-water lakes with marginal vegetation, Norfolk
Tabanus atratus F.—Beach-line rubble at Edgewater, Norfolk
Tabanus sulcifrons Macq.—Beach-line rubble at Edgewater, Norfolk

Order HYMENOPTERA Linnaeus 1758

Dasymutilla occidentalis (L.).—Beach-line rubble at Edgewater, Norfolk
Camponotus castaneus (Latr.).—Beach-line rubble at Edgewater, Norfolk
Chalybion cyaneus (F.).—Beach-line rubble at Edgewater, Norfolk
Microbembex monodonta (Say).—Beach-line rubble at Edgewater, Norfolk

Class ARACHNOIDEA Lamarck 1815

Order PHALANGIDA Latreille 1802

Liobunum vittatum (Say).—Beach-line rubble at Edgewater, Norfolk

Order ARANEIDA Lamarck 1818

Lycosa punctulata Htz.—Beach-line rubble at Edgewater, Norfolk
Lactrodectus mactans (Fabricius).—In stone piles near Lafayette River, Norfolk
Theridion tepidariorum (Koch.)—Beach-line rubble at Edgewater, Norfolk
Tetragnatha laboriosa Hentz.—Beach-line rubble at Edgewater, Norfolk
Misumenops sp.—Beach-line rubble at Edgewater, Norfolk

Order PYCNOGONIDA Latreille 1804

Callipallene brevirostris (Johnston).—Shallow water algae, Edgewater, Norfolk

Order CHILOPODA Latreille 1802

Lithobius atkinsoni Bollman.—Beach-line rubble at Edgewater, Norfolk

Phylum MOLLUSCA Linnaeus 1758

Class AMPHINEURA von Ihering 1876

Order POLYPLACOPHORA Gray 1821

Chaetopleura apiculata (Say).—Shoreline sands of Lynnhaven Inlet, Virginia Beach (marine)

Class GASTROPODA Cuvier 1798

Order PULMONATA Ehrenberg 1831

Melampus bidentatus Say.—Lafayette River, Norfolk (brackish) and Lynnhaven Inlet, Virginia Beach (marine and brackish)

Order PROSOBRANCHIATA

Acmaea simplex D'Orbigny.—Lynnhaven Inlet, Virginia Beach (marine) and Newport News (marine)
Acmaea campechiensis Gmelin.—Lyanhaven Inlet, Virginia Bearch (marine) and Newport News (marine)
Acmaea transversa Say.—Lynnhaven Inlet, Virginia Beach (marine) and Newport News (marine)
Odostomia impressa Say.—Willoughby Bay, Ocean View (marine)

Odostomia trifidia Totten.—Willoughby Bay, Ocean View (marine)
Sinum perspectivum Say.—Willoughby Bay, Ocean View (marine)
Crepidula convexa Say.—Lynnhaven Inlet, Virginia Beach (marine) and Little Creek (marine)
Crepidula fornicata (L.).—Lynnhaven Inlet, Virginia Beach (marine) and Little Creek (marine)
Crepidula plana Say.—Lynnhaven Inlet, Virginia Beach (marine) and Little Creek (marine)
Littorina irrorata (Say).—Mud-flats of Hampton Roads (marine and brackish)
Bittium virginicum Henderson and Bartsch.—Willoughby Bay, Ocean View (marine)
Urosalpinx cinereus (Say).—Oyster beds of Hampton Roads area (marine)
Eupleura caudata (Say).—Oyster beds of Hampton Roads area (marine)
Mitrella lunata Say.—Common in Hampton Roads area (marine)
Nassa vibex (Say).—Common in Hampton Roads area (marine)
Nassa trivatata (Say).—Common in Hampton Roads area (marine)
Nassa obsoleta (Say).—Common in Hampton Roads area (marine)
Anachis avara Say.—Lynnhaven Inlet, Virginia Beach (marine)
Busycon canaliculatum Say.—Lynnhaven Inlet, Virginia Beach (marine) and Little Creek (marine)
Mangilia plicosa C. B. Adams.—Willoughby Bay, Ocean View (marine)

Class PELECYPODA Goldfuss 1820
Order PRIONODESMACEA

Ostrea virginica Gmelin.—Common in Hampton Roads area (marine)
Pecten edgecombensis Dall.—Willoughby Bay, Ocean View (marine)
Pecten irradians Lamarck.—Willoughby Bay, Ocean View (marine)
Anomia simplex D'Orbigny.—Lynnhaven Inlet, Virginia Beach (marine) and Newport News (marine)
Anomia campechiensis Gmelin.—Lynnhaven Inlet, Virginia Beach (marine) and Newport News (marine)
Anomia transversa Say.—Lynnhaven Inlet, Virginia Beach (marine) and Newport News (marine)
Mytilus edulis L.—Lynnhaven Inlet, Virginia Beach (marine)
Brachidontes exustus L.—Lynnhaven Inlet, Virginia Beach (marine)
Modiolus demissus (Dillwyn).—Common in Hampton Roads area (marine)

Order TELEODESMACEA

Cardium magnum Born.—Lynnhaven Inlet, Virginia Beach (marine)
Mactra solidissima Dillwyn.—Lynnhaven Inlet, Virginia Beach (marine) and Little Creek (marine)
Venus mercenaria L.—Common in Hampton Roads area (marine)
Tagelus gibbus (Spengler).—Newport News (marine)
Macoma balthica (L.)—Lynnhaven Inlet, Virginia Beach (marine) and Little Creek (marine)
Donax fossor Say.—Common on sandy beaches of Hampton Roads area, especially Virginia Beach
Ensis directus Conrad.—Common on sandy beaches of Hampton Roads area, especially Virginia Beach
Siliqua costata (Say).—Sandy beaches of Hampton Roads
Mya arenaria L.—Mud-flats of Lynnhaven Inlet, Virginia Beach (marine)
Cyrtodaria costata (Say).—Willoughby Bay, Ocean View (marine)
Pholas costata L.—Oyster dredgings, Poquoson Flats, Hampton (marine)
Barnea costata L.—Oyster dredgings, Poquoson Flats, Hampton (marine)
Teredo navalis L.—Marine wood construction, Hampton Roads (marine)

Class CEPHALOPODA Cuvier 1798
Order TETRABRANCHIATA Owen 1832

Loligo pealei Lesueur.—Deepest waters of Hampton Roads towards ocean, from nets (marine)

Phylum ECHINODERMATA Laske 1778

Class ASTEROIDEA Burmeister 1837

Order SPINULOSA Perrier 1894

Asterias forbesi (Desor).—Common in oyster beds of Hampton Roads (marine) and Lynnhaven Inlet, Virginia Beach (marine)

Class HOLOTHUROIDEA Semper 1868

Order DENDROCHIROTA MacBride 1909

Thyone briareus (Lesueur).—Shallows of Lynnhaven Inlet, Virginia Beach (marine)

Order APODA Lampert 1885

Leptosynapta inhaerens (O. F. Müller).—Sands of Lynnhaven Inlet, Virginia Beach (marine)

Phylum CHORDATA* Haeckel 1874

Class ASCIDIACEA Blainville 1825

Order PTYCHOBRANCHIA Seeliger 1909

Molgula manhattensis (DeKay).—On piling, Lynnhaven Inlet, Virginia Beach (marine) and Little Creek (marine)

Styela sp.—On piling, Lynnhaven Inlet, Virginia Beach (marine) and Little Creek (marine)

Class AMPHIOXI J. Müller 1844

Branchiostoma virginiae Hubbs.—Rare in sands of Lynnhaven Inlet, Virginia Beach (marine)

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* Specimens of *Fundulus majalis*, *Menidia menidia*, *Bairdiella chrysura* and *Gobiosoma bosci* were commonly taken in net sweeps at Edgewater, Norfolk.

The Daily Activity Patterns of Some Freshwater Fishes[1]

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Although most fishermen and biologists know that fishes are more active at certain times of the day than at others and that various species exhibit different patterns in their daily activity, comparatively little data on the activity patterns of American freshwater fishes have been published. Hart (1931) noted that some species of fishes were caught in gill nets more frequently at night while others were most often caught in the daytime and attributed this difference to the activity periods of the various species. Spoor and Schloemer (1939) found that rock bass, *Ambloplites rupestris* (Rafinesque), were caught in largest numbers early in the morning and in the evening and they believed that this activity pattern was of rhythmic origin. Suckers, on the other hand, were taken in shallow water at night and in deep water during the day, indicating a diurnal migration which Spoor and Schloemer did not believe was rhythmic.

A few controlled experiments have also been made in various laboratories to determine the periodicity of activity and to determine the causes of this periodicity (Spencer, 1939; Spoor, 1941, 1946; Hoar, 1942).

Method of Study

The present paper is a by-product of two separate fishery investigations: the first by the senior author for the Minnesota Department of Conservation and the University of Minnesota on Lake of the Woods, Minnesota from 1939 to 1943 (Carlander, 1942); the second, by the junior author on Clear Lake, Iowa, in 1947 under the Iowa Cooperative Fishery Research Unit. In both of these studies, fishes were collected by gillnets of various mesh size and upon occasion these nets were lifted at one-, two- or three-hour intervals. By

1 Technical Paper No. 12 of Iowa Cooperative Fishery Research Unit based, in part, on data collected under Project No. 39 of the Industrial Science Research Institute of Iowa State College and the Iowa State Conservation Commission with the cooperation of the U. S. Fish and Wildlife Service.

2 The senior author wishes to thank the Minnesota Department of Conservation, Fisheries Research Unit, for permission to publish the data collected at Lake of the Woods while the author was in the employ of the Department. The author also wishes to express his appreciation to Dr. Lloyd L. Smith, Jr., and Dr. Samuel Eddy for their advice and supervision in the Lake of the Woods study and to Mr. Jesse Douglass and the many commercial fishermen and Conservation Department employees who helped in the field work.

3 The junior author wishes to express his appreciation to Mr. Charles King and Mr. D. H. Huey of the Iowa State Conservation Commission and to Doris Cleary for their assistance in the collection of data on Clear Lake.

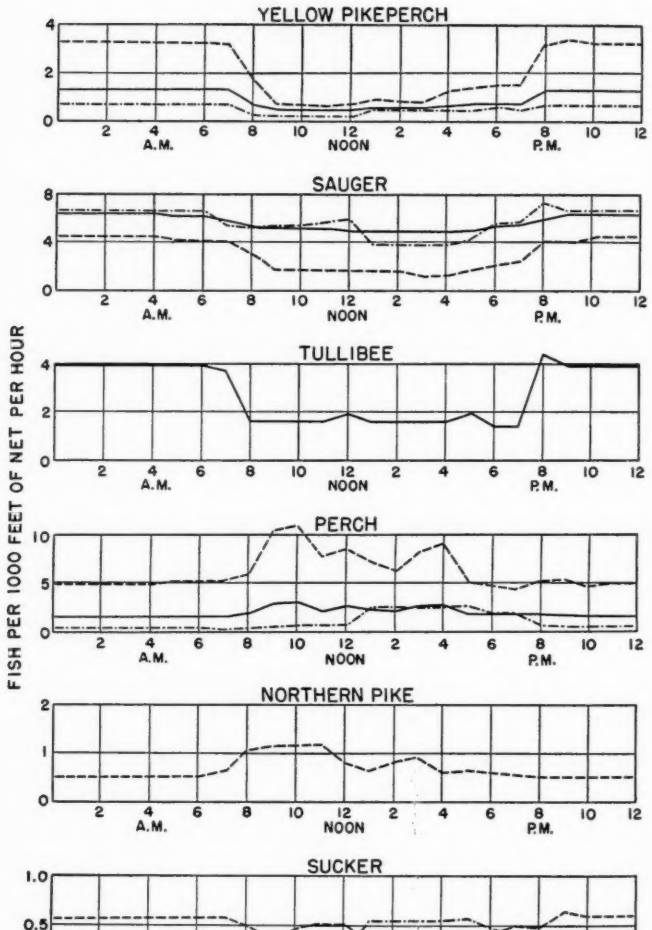

Fig. 1.—Hourly differences in the catch of fishes in gillnets, Lake of the Woods, Minnesota, 1939-1941.

converting the catch data to the number of fishes caught per hour for a given length of net, it was possible to determine the frequency with which each species was caught at different times of the day.

The use of these gillnet data in the study of fish activity is based upon the assumption that the more active a fish becomes, the greater is its possibility of being caught. It is recognized that factors other than the differences in activity of the fish may affect the number caught. During the daytime, fishes might see the net and avoid it more readily than at night. If the visibility of the net affects the capture, it must be assumed that some fishes are much less acute in vision or in the ability to recognize the danger of a net than are others, for some species were caught in greater numbers in the daytime than at night. Since fishes may also inhabit different parts of the lake at different times of the day, the number caught at any hour may not be correlated with their activity but with their presence in the particular habitat where the net is set. Nets were set in all available habitats and the catches in these various habitats were analyzed separately to detect such movements.

In the Lake of the Woods study, the fishes were caught in gillnets with mesh sizes ranging from 1½ to 4½ inches (stretch measure). The nets were not lifted between the hours 10 p.m. and 5 a.m. and therefore variations in the catch during these hours were not detected. The average catch per hour for this period was determined for comparison with the catch at other hours of the day. While it is realized that the length of time a net is set will affect the catch per hour, it is not believed that the errors in this case are sufficient to affect the conclusions. The data given in Fig. 1 are based on the fishes captured in 461 sets, each set consisting of 125 to 4000 feet of gillnet.

In the Clear Lake study, the nets were lifted at two-hour intervals, even through the night. The gillnets used in this study had mesh sizes ranging from 1½ to 6 inches (stretch measure). The data given in Fig. 2 are based on the fishes captured in 250 feet of gillnet set for a total of 272 hours.

DISCUSSION OF ACTIVITY PATTERN OF VARIOUS SPECIES

The fishes in this study can be divided into three general groups on the basis of their activity patterns: (1) those that are more active at night than during the day; (2) those that are more active during the daylight hours; and (3) those species that move from one habitat to another at different periods of the day. In this latter group are put some species on which the data are not particularly clear.

The yellow pikeperch, or walleyed pike, *Stizostedion vitreum* (Mitchill), was taken more frequently in the nets at night than in the daytime at both Lake of the Woods and Clear Lake.[4] The difference in the catch was more evident in the shallow water than in the deep water, suggesting that some of the pikeperch come into the shallows to feed at night. The catch data at

[4] According to the *t* test, the average catch per hour at night was significantly higher than the catch per hour for the day at Lake of the Woods.

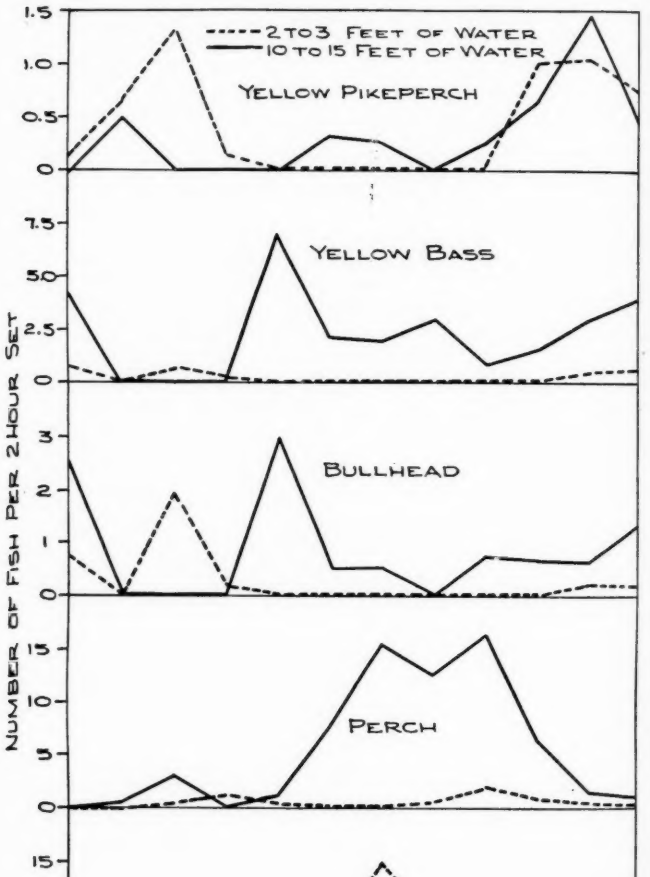

Fig. 2.—Hourly differences in the catch of fishes in gillnets, Clear Lake, Iowa, June to August, 1947.

Clear Lake indicate that the periods of greatest activity are at dusk and at dawn. Certain data at Lake of the Woods suggested that activity was affected by light intensities. On two successive days when the nets were set in shallow water, a shower and a darkening of the sky occurred at midday, and on both occasions a few pikeperch were caught during these hours although none were taken at other times of the two days. The storm itself may have excited the pikeperch.

The catch of saugers, *Stizostedion canadense* (Smith), and of tullibee, *Leucichthys artedi tullibee* (Richardson), in Lake of the Woods indicates that these species also move more at night than in the daytime. Hart (1931) reported that the cisco, *Leucichthys* sp., moved at night but that the sauger was more active in the daytime. His data on the sauger were based on only a few specimens.

The yellow perch, *Perca flavescens* (Mitchill), appears to be more active during the daytime both at Lake of the Woods and at Clear Lake. In the shallow water in both lakes, more perch were caught in the afternoon than in the morning, indicating a further difference in activity. Pearse and Achtenberg (1920) found little evidence of change in activity of yellow perch at different periods of the day, except for a moderate tendency to come nearer the surface at night. Evermann and Clark (1920, pp. 286-287) report that yellow perch and many other species come into shallow water to feed in the evening at Lake Maxinkuckee, Indiana. Webster (1943) found that yellow perch and white perch, *Morone americana* (Gmelin) came in on the shoals at dusk and remained in the shallow water until daylight in Bantam Lake, Connecticut. It is possible that this movement inshore may account for the decreased gillnet catches at night, but the shallow water sets do not show a proportionate increase. Seining might reveal the perch in water too shallow for efficient setting of a gillnet.

In Lake of the Woods the northern pike, *Esox lucius* L., was taken more often during the daylight hours. Only the shallow water catches are given since few northern pike were taken in deep water. Hart (1931) also found the northern pike to be more active during the daytime.

The common suckers, *Catostomus commersonni* (Lacépède), show in a striking degree a change of habitat. In the deeper waters they are caught mostly during the day time, but during the night they are taken in the shallow water. Spoor and Schloemer (1939) found that the suckers in Muskellunge Lake, Wisconsin, showed the same migration. Hart (1931) fishing in deeper water caught suckers only during the day.

The carp, *Cyprinus carpio* L., at Clear Lake gave some evidence of a migration the reverse of that found for the sucker. In the shallow water, the carp were taken almost exclusively in the day, while the largest numbers in water over 10 feet were taken from 2 to 4 a.m.

Black bullheads, *Ameiurus melas* (Rafinesque), at Clear Lake apparently come into the shallow water more at night than they do in the daytime, but comparatively little evidence on their activity pattern was secured. The high peak during the 8 to 10 a.m. period was caused by an unusually high catch in a single setting of the net and should be disregarded.

The yellow bass, *Morone interrupta* Gill, also shows evidence of coming into shallow water during the night. No yellow bass were taken in the shallow water during the daytime. In the deep water, the yellow bass show two periods of greater movement: 8 p.m. to 2 a.m. and 8 a.m. to 4 p.m.

SUMMARY AND CONCLUSIONS

Analysis of the catches of gillnets during various parts of the day indicates that yellow pikeperch, saugers, and tullibee are more active during the night than during the daytime; that perch and northern pike are more active during the day; that common suckers, black bullheads, and yellow bass come into shallow water during the night; and that carp appear to migrate into deeper water at night.

These differences in the activity patterns of the various species are probably affected by light intensity, temperature, feeding requirements, and inherent rhythmic cycles. The present paper merely describes the differences in the activity pattern of some common fishes and does not attempt to determine how these various factors affect activity.

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Annotated List of Original Descriptions in Scirpus

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The following list contains 1,672 names in the genus *Scirpus* (Cyperaceae) of which 1,350 are specific and 322 are subspecific. The present compilation was undertaken for the following reasons: (a) the list presents the genus in more usable form, more up to date, and more complete than it can be found elsewhere; (b) it makes more intelligible much early botanical literature — especially to students not specializing in the Cyperaceae; (c) it will contribute to the stability of the nomenclature in the natural genera of the Cyperaceae.

Although these advantages may result, it is recognized that the list has certain limitations due (1) to lack of herbarium material, particularly African species, making it impossible to work out the exact status of all names; (2) poorly defined sections for much Old World material making it impossible to give section names for all species; (3) lack of familiarity with some of the genera into which the synonyms fall making the placement of names in other genera only indicative of their approximate location and not necessarily final; (4) previous inadequate indexing of, and the scattered unpredictable locations of subspecific names and combinations making it probable that these are incompletely listed.

Published combinations in more than 50 genera either fall into the synonymy of *Scirpus* species, or have names in *Scirpus* in their synonymy. All but one of the genera may be found in the family Cyperaceae (*S. stygius* — *Juncus*). The names in *Isolepis* have been treated in *Amer. Midl. Nat.* 34: 523-734. 1945. 279 names listed are referable to *Eleocharis*. Other genera, commonly accepted as valid, which are involved include *Androcoma, Bulbostylis, Carex, Cyperus, Desmoschoenus, Eriophorum, Ficinia, Fimbristylis, Hemicarpha, Hypolytrum, Lipocarpha, Mariscus, Nomochloa, Rynchospora,* and *Schoenus*.

Scirpus:

abactus Ohwi, Bot. Mag. Tokyo 45: 186. 1931. (Japan # Actaeogeton)

aberrans Cherm. Bull. Soc. Bot. France 48: 423. 1922. (Madagascar # Actaeogeton)

ablepharus Griseb. Cat. Pl. Cub. 240. 1866.—*S. cubensis* Poepp. & Kunth var. *gracilis* (Boeck.) Beetle

acaulis Phil. Linnaea 29: 78. 1857-58.—*S. deserticola* Phil.

acicularis L. Sp. Pl. 1: 48. 1753.—*Eleocharis acicularis* (L.) R. & S. (All subspecific names are referable to the species.)

f. *fluitans* Doel. in Glück. Untersuch. über Wasser- und Sumpfgewächse 3: 575. 1911.—*Eleocharis acicularis* (L.) R. & S.

var. *longicaulis* Demaz. Cat. Pl. Omises Belg. 42. 1823.—*Eleocharis acicularis* f. *longicaulis* (Demaz.) Hegi

var. *natans* Schrad. in Lej. & Court. Fl. Belg. 1: 40. 1828.—*Eleocharis acicularis* f. *longicaulis* (Demaz.) Hegi

f. *rigidulus* Junge, Cup. Schleswigs-Holstein 253. 1908.—*Eleocharis acicularis* f. *rigidu-*

la (Reichenb.) Svenson
var. *rigidulus* Reichenb. Ic. Fl. Germ. 8: 37, fig. 697. 1846.—*Eleocharis acicularis* f. *rigidula* (Reichenb.) Svenson
f. *semimersus* Glück. Beih. Bot. Centralb. 39: 317. 1923.—*Eleocharis acicularis* (L.) R. & S.
f. *submersus* Glück. Biol. & Morphol. Untersuch. Wasser- und Sumpfgewächse 3: 573, fig. 103. 1911; Beihefte Bot. Centralb. 39: 317. 1923.
f. *submersus* (Hj. Nilss.) Porsild, Meddel. Groenl. 50: 370. 1912.—*Eleocharis acicularis* var. *submersus* (Nilss.) Svenson
var. *submersus* Hj. Nilss. Bot. Not. 144. 1888.—*Eleocharis acicularis* var. *submersus* (Nilss.) Svenson
var. *submersus* Blomgren. in Holmberg, Skand. Fl. 310. 1896.—*Eleocharis acicularis* f. *inundata* Svenson
f. *terrestris* Glück. Beih. Bot. Centralb. 39: 317. 1923.
f. *triangularis* Junge, Cyp. Schles.-Holst. 253. 1908.—*Eleocharis acicularis* f. *triangularis* (Reichenb.) Svenson
var. *triangularis* Aschers. & Graebn. Syn. Mitteleurop. Fl. 2: 304. 1903.—*Eleocharis acicularis* f. *triangularis* (Reichenb.) Svenson

acicularis Oed. Fl. Dan. fasc. 3, p. 7 et t. 167. 1764.—*Eleocharis palustris* (L.) R. & S.

acicularis Willd. in Kunth, Enum. Pl. 2: 142. 1837, nomen in synon.—*Eleocharis acicularis* (L.) R. & S.

acicularis Zanard. in Parl. Fl. Ital. 2: 67. 1852, nomen in notes on *Eleocharis zanardinii* Parl.—*E. atropurpurea* (Retz.) Kunth

acrostachys Steud. Flora 12: 148. 1829.—*Ficinia acrostachya* (Steud.) Clarke

acuminatus Muhl. Desc. Gram. 27. 1817.—*Eleocharis compressa* Sull.

acuminatus Steud. Flora 12: 146. 1829.—*Ficinia acuminata* (Steud.) Nees

acutangulus Roxb. Hort. Beng. 81. 1814, nomen; Roxb. Fl. Ind. ed. Carey & Wall. 1: 216. 1820; Roxb. Fl. Ind. ed. Carey 1: 213. 1832.—*Eleocharis fistulosa* (Poir.) Link

acutus Link, Jahrb. de Gew 1: 81. 1820; Willd. in Kunth, Enum. Pl. 2: 141. 1837.—*Eleocharis trichoides* (HBK) Kunth

acutus Muhl. in Bigelow, Fl. Bost. 15. 1814. (N. Am. # Pterolepis)
f. *congestus* (Farwell) Fern. Rhodora 23: 131. 1921.—*S. acutus* Muhl.
var. *malheurensis* (Henderson) Beetle, Univ. Wyoming Publics. 13: 5. 1948. (N. Am.)
var. *occidentalis* (Wats.) Beetle, Univ. Wyoming Publics. 13: 5. 1948. (N. Am.)

acutus Presl, Rel. Haenk. 1: 192. 1828.—*S. mucronatus* L.

acutus (R. Br.) Poir. Encyc. Meth. Suppl. 5: 102. 1817; (R. Br.) Spreng. Syst. Veg. 1: 203. 1825.—*Eleocharis acuta* R. Br.

adscendens Willd. in Kunth, Enum. Pl. 2: 198. 1837, nomen in synon. *Isolepis uninodis* Delile—*S. supinus* L. var. *uninodis* (Delile) Clarke

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aegyptiacus Decne, Ann. Sci. Nat. Ser. II. iv. 196. 1835.—*S. littoralis* Schrad.

aegyptiacus Poir. (See *S. aegyptiacus*) Encyc. 6: 770. 1804.—*S. tuberosus* Desf.

aemulans Steud. Syn. Pl. Glum. Pars. II. Cyp. 87. 1855.—*S. inclinatus* Aschers. & Graebn.

aemulans Steud. Zoll. Syst. Verz. Ind. Arch. 2: 62. 1854.—*S. grossus* L. f.

aestivalis Retz. Obs. 4: 12. 1786.—*Fimbristylis aestivalis* (Retz.) Vahl

aestivalis Wall. in Roxb. Fl. Ind. ed. Carey 1: 227. 1832.—*Fimbristylis squarrosa* Vahl

affinis Roth, Nov. Pl. Sp. 30. 1821.—*S. strobilinus* Roxb.

afflatus (Steud.) Benth. Fl. Hongk. 394. 1861; (Steud.) O. Ktze. Rev. Gen. Pl. 1: 757. 1891—*Eleocharis pellucida* Presl

africanus Beetle, Leafl. West. Bot. 4: 47. 1944.—*nanodes* Levyns.

aggregatus Ruiz in Boeck. Linnaea 36: 709. 1870, nomen in synon. *S. pungens* Vahl—*S. americanus* Pers. var. *triangularis* (Pers.) Beetle

aggregatus Steud. in Clarke in Dur. & Schinz, Consp. Fl. Afr. 5: 644. 1895, nomen in synon. *Ficinia tenuifolia* Kunth

agyptiacus Poir. Lam. Encyc. 6: 770. 1804; Poir. Encyc. Meth. Suppl. 5: 98. 1817.—*S. tuberosa* Desf. (See *S. aegyptiacus*)

albescens Phil. f. Cat. Pl. Vas. Chil. 310. 1881.

albescens Desv. Gay VI. 188. tab. 70. f. 2. 1853.—*S. inundatus* (R. Br.) Spreng.

albibracteatus (Nees & Meyen) O. Ktze. Rev. Gen. Pl. 1: 757. 1891.—*Eleocharis albibracteata* Nees & Meyen

albidus (Torr.) O. Ktze. Rev. Gen. Pl. 1: 757. 1891.—*Eleocharis albida* Torr.

albo-ater Schrad. in Nees, in Mart. Fl. Bras. ed. 2. 1: 102. 1842, nomen in synon. *Eleocharis ochreata* Nees

albomarginatus R. & S. Syst. Veg. 2: mant. 74. 1824.—*Eleocharis quadrangulata* (Michx.) R. & S.

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albovittatus Reichenb. Pl. Exsicc. & Icon. 18: 45. 1846; in Schur. Enum. Pl. Transs. 694. 1866.—*S. holoschoenus* L.

albus (L.) Salisb. Prod. 31. 1796.—*Rhynschospora alba* (L.) Vahl

alpinus (L.) Dalla Torre & Sarnth. Fl. Tirol. 6: I. 389. 1906.—*S. hudsonianus* (Michx.) Fern.

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altissimus Gilib. Exercit. 2: 514. 1792.—*S. lacustris* L.

amazonicus Beetle, Leafl. West. Bot. 4: 46. 1944 (S. Am. # Eleogiton)

ambiguus Schult. in R. & S. Syst. Veg. 2: mant. 85. 1824.—*S. divaricatus* Ell.

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americanus Pers. Syn. Pl. 1: 68. 1805. (N. Am. # Schoenoplectus)

var. *longibracteatus* Barros & Osten, Anal. Mus. Hist. Nat. Montivideo Ser. 2, 3: 203. 1931.—*S. americanus* var. *polyphyllus* (Boeck.) Beetle

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var. *polyphyllus* (Boeck.) Beetle, Am. Jour. Bot. 30: 399. 1943. (N. Am., S. Am. & N. Zealand)

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var. *pungens* f. *cordilleranus* Kük. & Barros, op. cit. 1931.—*S. americanus* Pers. var. *polyphyllus* (Boeck.) Beetle

var. *triangularis* (Pers.) Beetle, Am. Jour. Bot. 30: 400. 1943.—(Europe)

amphibius (Durieu) Bonnier, Fl. Compl. France, Suisse & Belg. 11: 80. 1931.—*Eleocharis amphibia* Dur.

anaachilloides Steud. (based on Lechler 2655—only a herbarium name)—*S. inundatus* Poir.

analecti Beetle, Brittonia 5: 148. 1944 (Mexico # Androcoma)

anceps Poir. Encyc. Meth. 6: 782. 1804.—*Cladium iridifolium* (Bory) Baker

anceps Willd. Ges. Naturf. Fr. Berl. Mag. 2: 288. 1808.—*Fimbristylis complanata* Link

andinus Phil. Anal. Univ. Chile 554. 1873.—*Eleocharis simularis* Clarke or *Eleocharis pauciflora* (Lightf.) Link, see pages 172 and 181 in Rhodora, 1929.

androgyne (R. Br.) Poir. Encyc. Meth. Suppl. 5: 98: 1817.—*Fimbristylis androgyna* R. Br.

andrzejowscii Bess. in Schult. in R. & S. Syst. Veg. 2: Mant. 536. 1824. (Europe # Pterolepis)

angachillensis Boeck. Linnaea 36: 496. 1870.—*S. inundatus* (R. Br.) Spreng.

angolensis Clarke in Dur. & Schinz, Consp. Fl. Afr. 5: 617. 1895.

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angustisquamis Beetle, Am. Jour. Bot. 33: 661. 1946. (Chile # Androcoma)

anisochaetus Wright in Sauv. Anal. Acad. Cienc. Habana 8: 78. 1871.—*Eleocharis flavescens* (Poir.) Urban

annuus Allioni, Fl. Pedem. 2: 271. t. 88 fig. 5. 1785.—*Fimbristylis annua* (All.) R. & S.

annuus Host, Gram. Austr. 3: 42. t. 63. 1801-1809.—*Fimbristylis dichotoma* (L.) Vahl

annuus Thuill. Fl. Paris, ed. 2: 22. 1799.—*Eleocharis ovata* (Roth) R. & S.

anomalus Retz. Obs. 5: 15. 1789.—*Hypolytrum latifolium* L. C. Rich (not *H. anomalum* Steud.)

antarcticus L. Mant. 2: 181. 1771. (See Clarke, Jour. Linn. Soc. 30: 314. 1894). (# Isolepis)

antarcticus Thunb. Prod. Pl. Cap. 17. 1794.

antarcticus Vahl, Enum. Pl. 2: 261. 1806.—*Bulbostylis barbata* (Rottb.) Clarke

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appendiculatus (Phil.) O. Ktze. Rev. Gen. Pl. 1: 757. 1891.—*Eleocharis appendiculata* Phil.

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apus Gray, Proc. Am. Acad. 10: 78. 1874.—*Fimbristylis vahlii* (Lam.) Link

aquatilis Rafin. Med. Repos. N. York 5: 352. 1808, nomen nudum et dubium.

arabicus Ehrenb. in Boeck. Linnaea 36: 716. 1870.—*S. littoralis* Schrad.

arechavaleta Boeck. Cyp. Nov. pt. 1, 18. 1888.

arenarius Benth. in Benth. & Muell. Fl. Austral. 7: 325. 1878.—*S. psammophilus* S. T. Blake

var. ? *setiformis* Benth. in Benth. & Muell. Fl. Austr. 7: 326. 1878.—*S. setiformis* (Benth.) Blake

arenarius Boeck. Linnaea 36: 471. 1870.—*Bulbostylis humilis* Kunth

arenicolus (Torr.) O. Ktze. Rev. Gen. Pl. 1: 757. 1891.—*Eleocharis arenicola* Torr.

argenteus Rottb. Progr. 27, 1772; Descr. Nov. Pl. 51. 1773.—*Fimbristylis argentea* (Rottb.) Vahl

argyrolepis Kierulff in Bunge, Reliquiae Lehm. 518 (342)—See Meinsh. Acta Hort. Petrop. 18: 262. 1900.—*Eleocharis*

aristatus (Presl) C. Richt. Pl. Europ. 1: 138. 1890.—*S. americanus* var. *triangularis* (Pers.) Beetle

aristatus Vahl, Enum. Pl. 2: 271. 1806; Willd. Sp. Pl. 1: 300. 1809.—*Fuirena glomerata* Lam.

arrhenopogon Hochst. in Clarke in Dur. & Schinz, Consp. Fl. Afr. 5: 625. 1895.—*Fuirena glomerata* Lam.

articulatus L. Sp. Pl. 1: 47. 1753. (Southern Asia & Australia # Actaeogeton)

var. *major* Boeck. Linnaea 36: 702. 1870.

var. *tenuis* Roth. Nov. Pl. Sp. 26. 1821.

arunensis Druce, Rep. Bot. Exch. Cl. Brit. Isles 7: 68. 1924, hybr. (# Pterolepis)

arvensis Retz. Obs. 4: 11. 1786.—*Fimbristylis ferruginea* (L.) Vahl

arvensis Roxb. Fl. Ind. ed. Carey 1: 224. 1832.—*Fimbristylis diphylla* (Retz.) Vahl

asiaticus Beetle, Am. Jour. Bot. 33: 662. 1946.—*S. wichurai* Boeck.

asper Presl, Rel. Haenk. 1: 194. 1830. (S. Am. # Androcoma)

var. *polystachya* Clarke, Engl. Bot. Jahrb. 30, Beibl. 68: 36. 1901.

asperiusculus Willd. in Bonpl. herb. Spring. Spec. 1: 213.—*Bulbostylis capillaris* (L.) Clarke (see Kunth, Enum. Pl. 2: 212. 1837).

asperulus Poir. Encyc. Meth. Suppl. 5: 104. 1817.—*Bulbostylis asperula* (Poir.) Clarke

atacamensis (Phil.) Boeck. Linnaea 36: 482. 1870. (S. Am. # Baeothryon)

var. *exscapus* Kurtz, Bol. Acad. Nac. de Cienc. Cordoba 15: 520. 1897.

atacamensis (Phil.) O. Ktze. Rev. Gen. Pl. 1: 757. 1891.—*Eleocharis atacamensis* Phil.

atratus Fern. Rhodora 2: 18. 1900.—*S. peckii* Britton

atricha Poir. Encyc. Meth. Suppl. 5: 103. 1817.—*Eleocharis*

atrichus (Palla) Dalle Torre & Sarnth. Fl. Tirol. 6: I. 389. 1906.—*S. pumilus* Vahl

atrichus (Palla) Lindm. Svensk. Fanerogamfl. 117. 1918.—*S. pumilus* Vahl same as preceding combination and of later date, therefore unnecessary

atrocinctus Fern. Proc. Am. Acad. 34: 502. 1899. (N. Am. # Eriophorum)

var. *brachypodus* Fern. Proc. Am. Acad. 34: 503. 1899.—*S. atrocinctus* f. *brachypodus* (Fern.) Blake
f. *brachypodus* (Fern.) Blake, Rhodora 15: 161. 1913. (N. Am.)
var. *condensatus* (Peck) House, N. York State Mus. Bull. 62: 233-234. 1921.—*S. atrocinctus* f. *brachypodus* (Fern.) Blake
var. *grandis* Fern. Rhodora 2: 17. 1900.—*S. cyperinus* var. *laxus* (Gray) Gilly

atrofractus Steud. Syn. Pl. Glum. Pars II. Cyp. 317. 1855.—*Eleocharis capitata* (L.) R. Br.

atropurpureo-vaginatus Boeck. Flora 65: 14. 1882.—*S. nodosus* Rottb.

atropurpureus Retz. Obs. 5: 14. 1789.—*Eleocharis atropurpurea* (Retz.) Kunth

atropurpureus Willd. in Kunth, Enum. Pl. 2: 150. 1837.—*Eleocharis capitata* (L.) R. Br.

atrosanguineus Boeck. Engl. Bot. Jahrb. 7: 276. 1886.—*Bulbostylis atrosanguinea* (Boeck.) Clarke

atrosanguineus Skottsb. Gefasspflanzenfl. Westpatagon. 6. 1924; Skottsb. Goteborgs Kgl. Vet. O. Vitt.-Sarnh. ser. 4, 28, pt. 3: fig. 1. 1924.—*Dichromena atrosanguinea* Desv.

atrovirens Willd. Enum. Pl. 1: 79. 1809. (N. Am. # Taphrogeton)
var. *flaccidifolia* Fern. Rhodora 40: 396. 1938.
var. *georgianus* (Harper) Fern. Rhodora 23: 134. 1921.
var. *georgianus* f. *angustispicatus* Fern. Rhodora 45: 296. 1943.
var. *georgianus* f. *cephalanthus* Fern. Rhodora 45: 296. 1943.
var. *georgianus* f. *viviparus* M.-Victorin, Trans. Roy. Soc. Canada, ser. 3, 23. pt. 2, sect. 5: 267, fig. 8. 1929.
subvar. *viviparus* Farwell, Amer. Midl. Nat. 11: 72. 1928.
var. *pallidus* Britton, Trans. N. York Acad. Sci. 9: 14. 1889.—*S. pallidus* (Britton) Fern.
f. *proliferus* Hermann, Rhodora 40: 77. 1938.
var. *pycnocephalus* Fern. Rhodora 8: 163. 1906.
f. sychnocephalus (Cowles) Blake, Rhodora 15: 161. 1913.

attenuatus Fr. & Savat. Enum. Pl. Jap. 2: 543. 1879.—*Eleocharis pellucida* Presl

aturensis Maury in Morot Jour. de Bot. 3: 199. fig. 8. 1889.—*Bulbostylis aturensis* (Maury) Clarke

auklandicus Boeck. Linnaea 36: 491. 1870. (# Isolepis)
var. *subcucullata* Clarke in Cheesman, Man. Fl. N. Zeal. 773. 1906.

auronites Nees (Herb. Berol.) acc. Boeck. Linnaea 36: 723. 1870.—*S. strobilinus* Roxb.

australiensis (Maiden & Betche) S. T. Blake, Proc. Roy. Soc. Queens. 51: 179. 1940. (# Isolepis)

australis Murr. in L. Syst. Veg. ed. 13 8: 85. 1774; Gmel. Syst. Veg. 1: 125. 1796.—*S. holoschoenus* L.

austriacus Aschers. & Graebn. in C. A. Lindm. Svensk. fanerogamfl. 117. 1918.—*S. cespitosus* var. *callosus* Bigel.

autumnalis L. Mant. 2: 180. 1771; L. Cod. 64. 1840.—*Fimbristylis autumnalis* (L.) R. & S.

autumnalis Rottb. Desc. Nov. Pl. 58. t. 17. fig. 3. 1773.—*Cyperus haspan* L.

avatshensis Komarov. in Fedde, Repert. 13: 163. 1914.—*S. rubrotinctus* Fern.

bachmannianus Boeck. in Clarke in Dur. & Schinz, Consp. Fl. Afr. 5: 634. 1895.—*Ficinia bicolor* (Nees) Pfeiff.

badius Presl, Rel. Haenk. 1: 193. 1830.—*S. americanus* var. *polyphyllus* (Boeck.) Beetle

baeothryon L. f. Suppl. 103. 1781; L. f. in Kunth, Enum. Pl. 2: 159. 1837.—*Eleocharis pauciflora* (Lightf.) Link

baeothryon Wahlenb. in Schrad. Fl. Germ. 1: 127. 1806; Wahlenb. Flor. Lapp. Suppl. 2. 1826.—*Eleocharis palustris* (L.) R. & S.

bahiensis Steud. Syn. Pl. Glum. Pars. II. Cyp. 83. 1855.—*Eleocharis flavescens* (Poir.) Urban.

bailii Kohts, Oestr. Bot. Zeitschr. 19: 334. 1869.—*Scirpus cespitosus* L.

baldwinianus Ell. in Schult. in R. & S. Syst. Veg. 2: mant. 85. 1824.—*Fimbristylis diphylla* (Retz.) Vahl
balearicus Willd. in Kunth, Enum. Pl. 2: 166. 1837.—*S. littoralis* Schrad.
balna Ham. in Clarke in Hook. Fl. Brit. Ind. 6: 659. 1894, nomen.—*S. strobilinus* Roxb.
bangalorensis Heyne in Wall. Cat. n. 3464. 1828.—*S. corymbosus* Heyne
barbatulus (sic) Kunth, Enum. Pl. 2: 583 (index) 1837.—*S. barbulatus* Kunth.
barbatus Rottb. Desc. et Ic. 52. t. 17. f. 4. 1773; Poir. Encyc. Meth. Suppl. 5: 104. 1817.—*Bulbostylis barbata* (Rottb.) Clarke
var. *americanus* Boeck. Linnaea 36: 753. 1870.
barbatus Vahl in Kunth, Enum. Pl. 2: 211. 1837.—*Fimbristylis vestita* (Kunth) Clarke
barbulatus Kunth, Enum. Pl. 2: 165. 1837.—*S. lacustris* L.
basilaris Clarke in Cheeseman, Man. Fl. N. Zeal. 772. 1906. (# Isolepis)
beccarii Boeck. Engl. Bot. Jahrb. 7: 275. 1886. (# Isolepis ? or # Actaeogeton ?)
bellardi Wahlenb. Fl. Lapp. Suppl. 15. 1826.—*Kobresia scirpina* Willd.
benedictus Beauverd in Bonnier, Fl. Compl. France, Suisse, & Belg. 11: 81. 1931.—*Eleocharis palustris* (L.) R. & S.
bengalensis Pers. Syn. Pl. 1: 68. 1805.—*Fimbristylis miliacea* (L.) Vahl
bergianus Spreng. Syst. Veg. 1: 212. 1825.—*S. antarcticus* L.
berlandieri Steud. Syn. Pl. Glum. Pars. II. Cyp. 103. 1855.—*Bulbostylis junciformis* (H.B.K.) Lindman
bernardinus Munz & Johnston, Bull. Torr. Bot. Club 52: 221. 1925.—*Eleocharis pauciflora* (Lightf.) Link var. *bernardina* (M. & J.) Svenson
bicapitatus Poir. Encyc. Meth. 6: 761. 1804.—*Ficinia bulbosa* (L.) Nees
biceps R. & S. Syst. Veg. 2: 134. 1817.—*Ficinia bulbosa* (L.) Nees
bicolor Spreng. Syst. Veg. 4. cur. Post. 28. 1827.—*S. thouarsianus* Schult.
bifolius Wallr. Sched. Crit. 27. 1822.—*Nomochloa rufa* (Huds.) Beetle
bispicatus Koen. in Roxb. Hort. Beng. 6. 1814, nomen; Fl. Ind. ed Carey & Wall. 1: 220. 1832.—*Fimbristylis schoenoides* Vahl
bisumbellatus Forsk. Fl. Aegypt.-Arab. 15. 1775.—*Fimbristylis dichotoma* (L.) Vahl
bivalvis Lam. Illustr. 1: 141. 1791.—*Fimbristylis longiculmis* Steud.
boecklerianus Schweinf. Bull. Herb. Boiss. App. 2: 50. 1894.—*Bulbostylis boecklerianus* (Schweinf.)
bonariensis (Nees) O. Ktze. Rev. Gen. Pl. 1: 757. 1891.—*Eleocharis bonariensis* Nees
bonariensis Poir. Encyc. Meth. 6: 763. 1804.—*Fimbristylis ferruginea* (L.) Vahl
boreanus Tourlet, Cat. Pl. Vasc. Indre-et-Loire 524. 1908, nomen in synon. *S. maritimus* L.
borneënsis Pfeiff. Mitt. Inst. Bot. Hamburg 7: 172. 1928 (Borneo)
brachyceras Hochst. Flora 24: I. Intell. 21. 1841, nomen; et A. Rich. Tent. Fl. Abyss. 2: 496. 1851. (Afr. # Actaeogeton)
brachyphyllus Link, Jahrb. de Gew. 1: 78. 1820. Willd in Kunth, Enum. Pl. 2: 212. 1837.—*Bulbostylis capillaris* (L.) Clarke
bracteatus Bigelow, N. Engl. Med. Jour. 5: 335. 1816.—*S. cespitosus* L. var. *callosus* Bigel.
brayii Hoppe, in R. & S. Syst. Veg. 2: 137. 1817.—*S. lacustris* L.
brevicaulis Levyns, Jour. South Afr. Bot. 10: 31. 1944.
breviculmis Boeck. Linnaea 36: 742. 1870.—*Bulbostylis breviculmis* (Kunth) Clarke
brevifolius Bernh. in Kunth, Enum. Pl. 2: 212. 1837, nomen.—*Bulbostylis barbata* (Rottb.) Clarke
brevifolius (R. Br.) Poir. Encyc. Suppl. 5: 99. 1817.—*Fimbristylis ferruginea* (L.) Vahl
brevifolius Rottb. Ges. Naturf. Fr. Neue Schr. 4: 190. 1803. (India)
brevifolius Roxb. Hort. Beng. 81. 1814, nomen; et Fl. Ind. ed. Carey & Wall. 1: 229. 1820; Fl. Ind. ed. Carey 226. 1832.—*Fimbristylis diphylla* (Retz.) Vahl
brevis D'Urv. Mem. Soc. Linn. Paris 4: 600. 1826.—*S. cernuus* Vahl var. *brevis* (D'Urv.) Skottsb.
brevivaginatus Boeck. Flora 41: 413. 1858.—*S. americanus* Pers. var. *longispicatus* Britton
bridgesii Boeck. Linnaea 36: 508. 1870.—*S. inundatus* (R. Br.) Spreng

brittonianus Piper, Contrib. U. S. Nat. Herb. 11: 157. 1906.—*S. paludosus* A. Nels.
briziformis Hutchinson in Hutchinson & Dalziel, Fl. S. Trop. Afr. 2: 465, in clavi, 466. 1936.—*Schoenus spadiceus* Vahl
brizoides Willd. in Link, Jahrb. de Gew. 1: 80. 1820.—*S. lineatus* Michx.
brizoides Sm. in Eggers. Flora Exsicc. Ind. Occ. Edidit: Adolph Toepffer 188 et seq. No. 189.—*Fimbristylis laxa* Vahl
brizoides Benth. in Benth. & Muell. Fl. Austral. 7: 326. 1878.—*S. oldfieldianus* Blake
bromeliaefolius Rudge, Pl. Guian. 19. t. 24. 1805.—*Diplasia karataefolia* Rich
brownei Spreng. Syst. Veg. 1: 204. 1825.—*Eleocharis geniculata* (L.) R. & S.
brownii Hook f. Handb. New Zel. Fl. 1: 298. 1867.—*Schoenus apogon* R. & S.
brunneo-vaginatus Boeck. Kjoeb. Vidensk. Meddel. 25. 1879-80.—*Bulbostylis sphaerocephalus* var. *brunneo-vaginata* Clarke
brunneus Muhl. Desc. Gram. 42. 1817.—*S. polyphyllus* Vahl
var. *crispus* Torr. N. York Acad. Sci. 3: 327. 1836.—*S. polyphyllus* Vahl
var. *viviparus* Torr. N. York Acad. Sci. 3: 327. 1836.—*S. polyphyllus* Vahl
brunonianus S. T. Blake, Proc. Roy. Soc. Queensl. 51: 179. 1940. (# Isolepis)
bucharicus Roshev. in Komorov. Fl. U.S.S.R. 3: 55 & 579. 1935. (Asia # Actaeogeton)
buettnerianus Boeck. Cyp. Nov. pt. I. 20. 1888.
bufonius Poir. Encyc. Meth. Suppl. 5: 105. 1817; Spreng. Syst. 1: 213. 1825.—*Bulbostylis capillaris* (L.) Clarke
bulbiferus Boeck. Linnaea 36: 482. 1870. (Afr. # Eleogiton)
bulbosus Rottb. Progr. 25. 1772; Rottb. Desc. Nov. Pl. 46. 1773.—*Ficinia trigyna* (L.) Pfeiff.
burchellii Clarke in Dur. & Schinz, Consp. Fl. Afr. 5: 618. 1895. (Afr. # Eleogiton)
burkei Clarke in Dur. & Schinz, Consp. Fl. Afr. 5: 618. 1895.
burkei (Clarke) K. Schum. in Just, Jahresb. 26: I. 329. 1898.—*Bulbostylis burkei* Clarke

caducus Delile, Fl. Egypte 9, t. 6 fig. 2. 1813.—*Eleocharis geniculata* (L.) R. & S.
caespitosus of many authors.—*S. cespitosus* L.
caespitosus Boeck. Linnaea 36: 488. 1870, partim—*S. pumilus* Vahl
caespitosus Willd. in Kunth, Enum. Pl. 2: 148. 1837.—*Eleocharis palustris* (L.) R. & S.
caldwellii Cook, Trans. Roy. Soc. New Zealand 76: 568. 1947. (New Zeal. # Bolboschoenus)
californicus (Mey.) Britton, Trans. N. York Acad. Sci. 11: 79. 1892.—*S. californicus* (Mey.) Steud. Same as following combination and of later date, therefore unnecessary.
californicus (Mey.) Steud. Nom. Bot. ed. II. 2: 538. 1841. (N. & S. Am. # Pterolepis)
var. *chamissoi* (Nees) Comb. Nov. (based on *Malacochaete riparius* Presl. var. *chamissoi* Nees, Mart. Fl. Bras. 2: 107. 1842.)
var. *paschalis* (Kük.) Comb. nov. (based on *S. riparius* Presl. var. *paschalis* Kük. in Fedde, Repert. 16: 432. 1920.)
var. *spoliatus* Barros, Lilloa, Revista de Bot. 1: 69. 1937.—*S. californicus* var. *tereticulmis* (Steud.) Beetle
var. *tatora* (Kunth) Barros, Darwiniana 6: 126. 1942.—*S. tatora* Kunth
var. *tereticulmis* (Steud.) Beetle, Madroño 6: 48. 1941. (S. Am.)
calocarpus S. T. Blake, Proc. Roy. Soc. Queensland 51: 179. 1940. (# Isolepis)
calolepis (Schum.) O. Ktze. Rev. Gen. Pl. 3: II. 336. 1898.—*Fuirena calolepis* Schum.
campestris Roth, Usteri, Ann. Bot. 14: 18. 1795; Willd. in Kunth, Enum. Pl. 2: 148. 1837.—*Eleocharis pauciflora* (Lightf.) Link
campestris Britton in Britton & Brown, Fl. N.U.S. 1: 267. 1896.—*S. paludosus* A. Nels.
var. *fernaldi* Bartlett, Rhodora 8: 163. 1906.—*S. maritimus* L. var. *fernaldi* (Bicknell) Beetle
var. *longi-spicatus* Bates, Univ. Nebr. Studies 14: 155. 1914.—*S. paludosus* Nels.
var. *novae-angliae* (Britt.) Fern. Rhodora 8: 163. 1906.—*S. robustus* Pursh var. *novae-angliae* (Britton) Beetle
var. *paludosus* (Nels.) Fern. Rhodora 8: 162. 1906.—*S. paludosus* Nels.

campestroides Roxb. in Coet. Merc. I. O. Mus. tab. 744. (fide Arn.); Wight. Contrib. Bot. Ind. 110. 1834.—*S. pectinatus* Roxb.
camptotrichus C. Wright in Sauv. Fl. Cubana 172. 1871; C. Wright in Sauv. Anal. Acad. Cienc. Habana 8: 78. 1871.—*Eleocharis nana* Kunth
camptschaticus (sic) Kunth, Enum. Pl. 2: 158. 1837.—*Eleocharis kamschatica* (Mey.) Kom.
canaliculato-triqueter Steud. Syn. Pl. Glum. Pars. II. Cyp. 318. 1855.—*S. grossus* L. f.
canbyi Gray in Canby, Proc. Acad. Nat. Sci. Philad. 18. 1864.—*S. etuberculatus* (Steud.) O. Ktze.
candelabrum Link, Jahrb. de Gew. 1: 80. 1820; Willd. in Kunth, Enum. Pl. 2: 232. 1837. —*Fimbristylis diphylla* (Retz.) Vahl
capensis Burm. f. Fl. Cap. Prod. 3. 1768. —*S. maritimus* L.
capensis Rottb. Progr. 24. 1772; Rottb. Desc. Nov. Pl. 53. 1773. —*Ficinia bulbosa* (L.) Nees
capillaceus Ell. Sk. Fl. S. Car. 1: 75. 1816.—*Eleocharis parvula* (R. & S.) Link
capillaceus Griseb. Cat. Pl. Cub. 239. 1866.—*Eleocharis alveolata* Svens.
capillaceus (Nees) O. Ktze. Rev. Gen. Pl. 1: 757. 1891.—*Eleocharis*
capillaceus Muhl. in Nees, Linnaea 9: 291. 1834.—*Bulbostylis capillaris* (L.) Clarke
capillaris L. Sp. Pl. 1: 49. 1753.—*Bulbostylis capillaris* (L.) Clarke
var. *elatior* Griseb.—*Bulbostylis capillaris* var. *elatior* Osten
var. *sphaerolepis* Boeck. Allg. Bot. Zeit. 2: 55. 1896.
var. *tenuifolia* Pilger, Engl. Bot. Jahrb. 30: 142. 1901.
capillaris Rottb. in Nees, Linnaea 9: 291. 1834.—*Bulbostylis puberula* (Poir.) Clarke
capillifolius Parl. Fl. Ital. 2: 83. 1852. (# Eleogiton)
capitatus Burm. f. Fl. Ind. 21. 1769.—*Ficinia uncinata* Kunth
capitatus L. Sp. Pl. 1: 48: 1753.—*Eleocharis capitata* (L.) R. Br.
capitatus Muhl. Desc. Gram. 31. 1817.—*Eleocharis albida* Torr.
capitatus Schreb. Spicil. Fl. Lips. 60. 1771.—*Eleocharis ovata* (Roth) R. & S.
capitatus Walt. Fl. Car. 70. 1788.—*Eleocharis obtusa* (Willd.) Schult.
capitatus Willd. in Kunth, Enum. Pl. 2: 145. 1837.—*Eleocharis tenuis* (Willd.) Schultes
capitatus Willd. Sp. Pl. 1: 294. 1809, in part; H.B.K. Nov. Gen. et Sp. 1: 225. 1816. —*Eleocharis caribaea* (Rottb.) Blake
capsularis Lour. Fl. Cochinch. 44. 1793.
caribaeus Griseb. Wiss. Goett. Abh. 7: 269. 1857.—*Eleocharis flavescens* (Poir.) Urban
caribaeus Rottb. Descr. Pl. Rar. Ic. Ill. 24. 1773.—*Eleocharis caribaea* (Rottb.) Blake
caricinus Schrad. Fl. Germ. 1: 132. 1806.—*Nomochloa compressa* (L.) Beetle
caricis Retz. Fl. Scand. Prod. 11. 1779.—*Nomochloa compressa* (L.) Beetle
var. *brevifolia* Clarke in Hook. Fl. Brit. Ind. 660-661. 1894.—*Nomochloa compressa* (L.) Beetle var. *brevifolia* (Clarke in Hook.) Beetle
var. *dissita* (Duthie) Clarke, op. cit. 1894.—*Nomochloa compressa* (L.) Beetle
var. *sikkimensis* Clarke, op. cit. 1894.
carinatus (H. & A.) Gray, Proc. Am. Acad. 7: 392. 1868.—*S. koiolepis* (Steud.) Gleason
carinatus Sm. Engl. Fl. 1: 60. t. 1983. 1809.—*S. lacustris* L. var. *tabernaemontani* (Gmel.) Doell.
carniolicus (Koch) O. Ktze. Rev. Gen. Pl. 1: 757. 1891; Thome, Fl. Deutsch. 1: 259. 1903; Aschers. & Graebn. Syn. Mitteleurop. Fl. 2: 304. 1904.—*Eleocharis carniolica* C. Koch.
carolinianus Lam. Illustr. 1: 142. 1791.—*Fimbristylis caroliniana* (Lam.) Fern.
carolinianus Panz. in Kunth, Enum. Pl. 2: 282. 1837.—*Rhynchospora nitens* (Vahl) Gray
carsei Kük. Trans. N. Zel. Inst. 48: 241. 1916. (New Zel.)
cartilagineus Poir. Ency. Meth. Suppl. 5: 103. 1817; Spreng. Syst. Veg. 1: 208. 1825. —*S. antarcticus* L.
var. *alpina* (Hook. f.) Benth. & Muell. Fl. Austral. 7: 326. 1878.
var. *propinqua* (Nees) Benth. & Muell. Fl. Austral. 7: 326. 1878.

castaneus Michx. Fl. Bor. Am. 1: 31. 1803.—*Fimbristylis spadicea* (L.) Vahl
castaneus Muhl. Desc. Gram. 38. 1817.—*Fimbristylis coarctata* Schwein.
castaneus Willd. in Kunth, Enum. Pl. 2: 227. 1837.—*Fimbristylis autumnalis* (L.) R. & S.
cellulosus (Torr.) O. Ktze. Rev. Gen. Pl. 1: 757. 1891.—*Eleocharis cellulosa* Torr.
cephalotes Jacq. Hort. Vindob. 1: 42. t. 97. 1770.—*Cyperus kyllingia* Endl.
cephalotes L. Sp. Pl. 2: 76. 1762.—*Rhychospora cephalotes* (L.) Vahl
cephalotes Walt. Fl. Carol. 71. 1788.—*Lipocarpha humboldtiana* Nees
cernuus Vahl, Enum. Pl. 2: 245. 1806. (Cosmopol. # Isolepis)
  var. *alpina* Benth. in Benth. & Muell. Fl. Austral. 7: 326. 1878.
  f. *aphyllus* M. Barros, Anal. Mus. Arg. Cienc. Nat. 38: 144. 1935.
  var. *australiensis* Maiden & Betche, Proc. Linn. Soc. New S. Wales 33: 316. 1908. —*S. australiensis* (Maiden & Betche) Blake
  var. *brevis* D'Urv. Mem. Soc. Linn. Paris 4: 600. 1825.
  var. *brevis* Skottsb. Wiss. Ergebn. Schwed. Sudpolar-Exped. 4, Lief. 10: 41. 1909.
  var. *californicus* (Torr.) Beetle, Rhodora 46: 145. 1944. (N. Am.)
  var. *dura* Clarke, Engl. Bot. Jahrb. 30, Beibl. 68: 29. 1901.
  var. *propinqua* Benth. in Benth. & Muell. Fl. Austral. 7: 326. 1878.
  var. *pygmaea* Dusen, Svensk. Exp. Magell. 3, pt. 5: 212. 1900.
  f. *pygmaea* Lindm. Bihang Tillk. Sv. Vet. Akad. Handl. 26, Afd. 3, No. 9: 21. 1900.
  var. *subtilis* (Kunth) Clarke, in Dur. & Schinz, Consp. Flor. Afr. 5: 619-620. 1895.
cespitosus Boeck. Linnaea 36: 488. 1870, partim,—*S. pumilus Vahl* (spelled *caespitosus* by Boeck.)
cespitosus Ehrh. Beitr. 6. 84, 1787-92. nomen.
cespitosus L. Sp. Pl. 1: 48. 1753. (Europe, # Boeothryon)
  var. *austriacus* Aschers. & Graebn. Syn. Mitteleurop. Fl. 2: ab. 2, 300. 1904.—*S. cespitosus* var. *callosus* Bigel.
  var. *callosus* Bigelow, Fl. Bost. ed. 2, 21. 1824. (Northern hemisph.)
  var. *comosus* Bonnigh. Prod. Fl. Monast. 14. 1824.—*S. cespitosus* L. var. *callosus* Bigel.
  var. *delicatulus* Fern. Rhodora 23: 55. 1921. (N. Am.)
  var. *germanicus* Aschers. & Graebn. Fl. Nordostd. Flachl. 135. 1898.—*S. cespitosus* L.
  var. *nemorosus* Roth, Tent. Fl. Germ. 2: 53. 1789.—*S. cespitosus* L.
  var. *vulgaris* Reichenb. in Moessl. Handb. der Gewachsk. 74. 1827.—*S. cespitosus* L.
cespitosus (R. Br.) Poir. Encyc. Meth. Suppl. 5: 99. 1817.—*Fimbristylis caespitosa* R. Br.
cespitosus Pollich, Hist. Pl. Pal. 1: 39. 1776-1777.—*Eleocharis pauciflora* (Lightf.) Link
chaeta Schult. in R. & S. Syst. Veg. 2: mant. 72. 1824.—*Eleocharis acicularis* (L.) R. & S.
chaetarius Spreng. Syst. Veg. 1: 203. 1825.—*Eleocharis setacea* (Retz.) R. Br.
chaetodes Link in Buch, Beschr. Canar. Ins. 138. 1819; (Abh. Akad. Berl. 1816-1817). —*S. cernuus* Vahl
chamissoi Schrad. in Nees, in Mart. Fl. Bras. ed. 2; 1: 107. 1842: Schrad. in Boeck. Linnaea 36: 717. 1870.—*S. californicus* (Mey.) Steud.
chilensis Meyen, Reise Erd. 1: 380. 1834, nomen; et Nees & Meyen, Linnaea 9: 293. 1834, nomen; Nees in Myen, Act. Acad. Cur. 19: 93. suppl. 1843. (S. Am. # Schoenoplectus)
  var. *longisetis* (Kük.) Beetle, Am. Jour. Bot. 33: 663. 1946 (N. Am.)
chinensis Munro in Seem. Bot. Voy. Herald 423. 1857.—*S. ternatanus* Reinw.
chinensis Osb. Dagbok Ostind Resa 220. 1753.
chirigota Wright, in Sauv. Fl. Cub. 176. 1871.—*Bulbostylis hirta* (Thunb.) Svenson
chlorostachys Levyns, Jour. South Afr. Bot. 10: 29. 1944.
chloroticus Phil. Anal. Univ. Chile 93: 480. 1896.—*S. cernuus* Vahl
chubutensis Clarke, Kew Bull. Add. ser. 8: 89. 1908.—*S. nevadensis* S. Wats. var. *remireoides* (Griseb.) Beetle
ciliaris L. Mant. 2: 182. 1771.—*Fuirena ciliaris* (L.) Roxb.

ciliaris Pers. Syn. 1: 77. 1805.—*Fuirena*
ciliatifolius Ell. Sk. S. Car. 1: 82. 1816; Darlint. Florul. Cestr. 7. 1826.—*Fimbristylis*
ciliatus Steud. Syn. Pl. Glum. Pars II. Cyp. 86. 1855.—*S. validus* Vahl (fide *Wright 356* of U.S. North Pac. Expl. Exped. in N.Y.B.G.)
ciliolatus Boeck. Kjoeb. Vidensk. Meddel. 152. 1871; Boeck. Linnaea 38: 380. 1874.—*Fimbristylis*
cinero-fuscus St. Vicent in Link, Jahrb. de Gew. 1: 81. 1820, nomen.
cinereofuscus Willd. in Kunth, Enum. Pl. 2: 236, 1837.—*Fimbristylis ferruginea* (L.) Vahl var. *sieberiana* (Kunth) Boeck.
cinnamometorum Vahl, Enum. Pl. 2: 278. 1806.—*Fimbristylis cyperoides* R. Br.
cinnamomeus Boeck. Engl. Bot. Jahrb. 5: 505. 1884.—*Bulbostylis cinnamomea* (Boeck.) Clarke
circinatus Boeck. Linnaea 36: 762. 1870.—*Bulbostylis*
clarkei Stapf. Trans. Linn. Soc. Ser. II. 4: 244. 1894. (Asia # Paucispicata)
var. *pakapakensis* (Stapf.) Beetle, Am. Jour. Bot. 33: 665. 1946. (Asia # Paucispicata)
clathratus Reichenb. Ic. Fl. Germ. 8: 39. 1846.—*S. setaceus* L. or *cernuus* Vahl?
clementis Jones, Contrib. West. Bot. No. 14, 21. 1912. (Calif. # Baeothryon)
clintonii Gray, Am. Jour. Sci. Ser. II. 38: 290. 1864. (N. Am. # Baeothryon)
coahuilensis Svens. Jour. Arn. Arb. 25: 46. 1944. (Mex. # Oxycaryum)
coarctatus Ell. Sk. Fl. S. Car. 1: 83. 1816.—*Bulbostylis capillaris* (L.) Clarke
coerulescens (Steud.) O. Ktze. Rev. Gen. Pl. 3: II. 336. 1898.—*Fuirena coerulescens* Steud.
cognatus Hance, Am. Sc. Nat. Ser. IV. 15: 228. 1861.—*S. mucronatus* affin.
coleotrichus Boeck. Linnaea 36: 763. 1870.—*Fimbristylis*
collinus Boeck. Linnaea 36: 746. 1870.—*Ficinia*
coloradoensis Britton, Torreya 4: 93. 1904.—*Eleocharis parvula* (R. & S.) Link var. *anachaeta* (Torr.) Svenson
comosus Dum. Fl. Belg. 143. 1827. (cf. *cosmosus*)
comosus Wall. in Roxb. Fl. Ind., ed. Carey & Wall. 1: 234. 1820.—*Eriophorum comosum* (Wall.) Wright
compactus Hoffm. Deutschl. Fl. ed. II. 1. I. 25. 1804.—*S. maritimus* L.
compactus Poir. Encyc. Meth. Suppl. 5: 102. 1817; Spreng. Syst. Veg. 1: 202. 1825.—*Eleocharis spiralis* (Rottb.) R. & S.
complanatus Retz. Obs. 5: 14. 1789.—*Fimbristylis complanata* (Retz.) Link or *F. autumnalis* (L.) R. & S. var. *complanata* (Retz.) Barros
compressus Moench. Meth. 349. 1794.—*Eleocharis ovata* (Roth) R. & S.
compressus (L.) Pers. Syn. Pl. 1: 66. 1805.—*Nomochloa compressa* (L.) Beetle
var. *elynoides* (Murr.) Dalle Torre & Sarnth. Fl. Tirol. 6: I. 398. 1906.
concolor Maxim. Bull. Acad. Petersb. 31: 110. 1887.
confervoides Poir. Encyc. Meth. 755. 1804. (Cosmop. # Eleogiton)
confusus N. E. Brown, Kew Bull. 300. 1921. (Afr. # Actaeogeton)
congdoni Britt. Torreya 18: 36. 1918. (N. Am. # Taphrogeton)
var. *minor* Henderson, Rhodora 32: 21. 1830.—*S. congdoni* Britt.
congestus Buch.-Ham. in D. Don, Prod. Fl. Nep. 41. 1825.—*Eleocharis congesta* D. Don.
congestus Reichenb. in Kunth, Enum. Pl. 2: 211. 1837.—*Bulbostylis junciformis* (H.B.K.) Lindman
conglomeratus H.B.K. Nov. Gen. et Sp. 1: 427. 1816.—*Eleocharis palustris* (L.) R. & S.
congruus (Nees) S. T. Blake, Proc. Roy. Soc. Queensland 48: 90. 1937. (Austr. # Isolepis)
conicus Presl. in Mert. & Koch, Deutschl. Fl. 1: 427. 1823, nomen—*Eleocharis palustris* (L.) R. & S.
coniferus Poir. Ency. Meth. 6: 756. 1804.—*Bulbostylis conifera* (Poir.) Beetle
conostachys Boeck. Linnaea 36: 756. 1870.—*Bulbostylis conostachya* (Boeck.) Beetle
consanguineus Boeck. Kjoeb. Vidensk. Meddel. 138. 1869; Boeck. Linnaea 36: 754. 1870.—*Bulbostylis consanguinea* Nees

conspersus Boeck. Linnaea 36: 505. 1870.—*S. sulcatus* Thouars.
conspersus Laing, Trans. N. Zel. Inst. 47: 19. 1915.—*S. inundatus* (R. Br.) Spreng.
conspersus Schrad. in Kunth, Enum. Pl. 2: 153. 1837.—*Eleocharis geniculata* (L.) R. & S.
constitutionis Phil. Anal. Univ. Chile 93: 483. 1896.—*S. inundatus* (R. Br.) Spreng.
constrictus Schrad. in Kunth, Enum. Pl. 2: 153. 1837.—*Eleocharis geniculata* (L.) R. & S.
coreanus Palla, Monde des Plantes 11: 10. 1909, nomen; Palla, Oestr. Bot. Zeitschr. 59: 188. 1909.
cornatus Wright in Sauv. Anal. Acad. Cienc. Habana 8: 81. 1871; Wright in Sauv. Fl. Cub. 177. 1871.—*Fimbristylis squarrosa* Vahl
coronarius Vahl, Enum. Pl. 2: 261. 1806.—*Cyperus coronarius* (Vahl) Kunth
coronatus Steud. Flora 136. 1829.—*Ficinia setiformis* Schrad.
corymbiferus Wright in Sauv. Anal. Acad. Cienc. Habana 8: 80. 1871: Wright in Sauv. Fl. Cub. 176. 1871.—*Rhynchospora corymbifera* Kük.
corymbosus Forsk. Fl. Aegypt.-Arab. 14. 1775.—*S. tuberosus* Desf.
corymbosus Heyne in Roth, Nov. Pl. Sp. 28. 1821.—*S. brachyceras* Hochst.
  var. *microstachys* Boeck. Linnaea 36: 706. 1870.
  var. *minor* Boeck. in Ridl. Jour. Linn. Soc. 20: 335. 1883.
corymbosus L. Cent. Pl. 2: 7. 1756.; L. Amoen. Acad. 4: 303. 1759.—*Rhynchospora corymbosus* (L.) Macbr.
comosus Dumort, Mich. Agr. No. 268.—*Eleocharis acicularis* (L.) R. & S. (? cf. *comosus*)
costatus (A. Rich.) Boeck. Linnaea 36: 511. 1870. (# Isolepis)
  var. *gracilis* Boeck. Linnaea 36: 511. 1870.
  var. *macer* H. Cherm. Bull. Soc. Bot. France 74: 607. 1927.
costulatus (Nees & Mey.) O. Ktze. Rev. Gen. Pl. 1: 757. 1891.—*Eleocharis*
crassiculmis Schrad. in Nees, in Mart. Fl. Bras. ed. 2; 1: 99. 1842. (# Eleogiton)
crassiusculus Hook. f. in Benth. & Muell. Fl. Austral. 7: 326. 1878.—*S. lenticularis* Poir.
crassus C. A. Mey. in Meinsch. Acta Hort. Petrop. 18: 262. 1901.—*Eleocharis palustris* (L.) R. & S.
crinalis Griseb. Wiss. Goett. Abh. 19: 265. 1874; Pl. Lorentz 217. 1874.—*Eleocharis crinalis* (Griseb.) Clarke
criniger Gray, Proc. Amer. Acad. 7: 392. 1868.—*Eriophorum crinigerum* (Gray) Beetle
crinitus R. & S. Syst. Veg. 2: 125. 1817, in synon.—*Ficinia filiformis* (Lam.) Schrad.
cubensis Poeppig. & Kunth, in Kunth, Enum. Pl. 2: 172. 1837. (Tropics # Oxycaryum)
  var. *gracilis* (Boeck.) Beetle, Rhodora 46: 146. 1944. (Tropics)
  var. *minor* Wright in Sauv. Fl. Cub. 174. 1871; Sauv. Anal. Acad. Ci. Habana 8: 82. 1871.—*S. cubensis* var. *gracilis* (Boeck.) Beetle
  var. *paraguayensis* Kük. in Barros, Anal. Mus. Arg. Cienc. Nat. 38: 150. 1935.—*S. cubensis* var. *gracilis* (Boeck.) Beetle
cumingii Boeck. Linnaea 36: 491. 1870.—*Carex setifolia* O. Ktze.
cunninghamii (Boeck.) O. Ktze. Rev. Gen. Pl. 1: 757. 1891.—*Eleocharis*
cuspidatus R. & S. Syst. Veg. 2: 67. 1817.—*Tetraria*
cuspidatus Roth, Nov. Pl. Sp. 31. 1821.—*Fuirena wallichiana* Kunth
cuspidatus Willd. in Kunth, Enum. Pl. 2: 213. 1837.—*Bulbostylis puberula* (Poir.) Clarke
custoris Hegetschw. Fl. Schweiz. 49. 1839.—*S. lacustris* L.
cylindraceus Willd. in Kunth, Enum. Pl. 2: 238. 1837.—*Fimbristylis spadicea* (L.) Vahl
cylindricus (Torr.) Britton, Trans. N. York Acad. Sci. 11: 79. 1892.—*S. etuberculatus* (Steud.) O. Ktze.
cymosus Lam. Illustr. 1: 141. 1791.—*Fimbristylis rigida* Kunth
cymosus Poir. Encyc. Meth. Suppl. 5: 99. 1817.—*Fimbristylis cymosa* R. Br.
cymosus Spreng. Syst. Veg. 1: 209. 1825.—*Rhynchospora distans* Willd.
cyperiformis Muhl. Desc. Gram. 41. 1817.—*Cyperus filiculmis* Vahl var. *macilentus* Fern.

cyperinus (L.) Kunth, Enum. Pl. 2: 170. 1837. (N. Am. # Trichophorum)
var. *andrewsii* Fern. Rhodora 2: 16. 1900.—*S .cyperinus* (L.) Kunth
var. *brachypodus* (Fern.) Gilly, Iowa State College Jour. of Science 21: 84. 1946.
f. *cephaloideus* (Sheldon) Beetle, Rhodora 46: 146. 1944. (N. Am.)
var. *concolor* Makino, Ill. Flora Japan 779. 1924.
var. *condensatus* Fern. Rhodora 2: 16. 1900.—*S. cyperinus* (L.) Kunth
var. *congestus* House, N. Y. State Mus. Bull. 62: 233-34. 1921.—*S. cyperinus* f. *cephaloides* (Sheldon) Beetle
var. *eriophorum* (Michx.) Britt. Trans. N .Y. Acad. 11: 82. 1892.—same as following combination and of later date, therefore unnecessary.
var. *eriophorum* (Michx.) O. Ktze. Rev. Gen. Pl. 1: 757. 1891. (N. Am.)
var. *eriophorum* (Michx.) O. Ktze. f. *confertus* Beetle, Am. Jour. Bot. 33: 663. 1946.
var. *laxus* (Gray) Beetle, N. Am. Fl. pt. 8. 492. 1947. (N. Am.)
var. *laxus* (Gray) Gilly, Iowa State Jour. Sci. 21: 82. 1946.
var. *normalis* O. Ktze. Rev. Gen. Pl. 1: 757. 1891.—*S. cyperinus* (L.) Kunth
var. *pelius* Fern. Rhodora 8: 164. 1906.—*S. cyperinus* (L.) Kunth
var. *pelius* f. *condensatus* (Fernald) Blake, Rhodora 15: 162. 1913.—*S. cyperinus* (L.) Kunth f. *cephaloides* (Sheldon) Beetle
var. *pelius* f. *congestus* (House) House, N. York State Mus. Bull. 254: 150. 1924.—*S. cyperinus* f. *cephaloideus* (Sheldon) Beetle
var. *rubricosus* (Fern.) Gilly, Iowa State College Jour. of Science 21: 82. 1946.—*S. cyperinus* var. *eriophorum* (Michx.) O. Ktze.
var. *wichurai* (Boeck.) Hisauchi, Jour. Jap. Bot. 10: 455. 1934.
cyperoides Hemsl. Biol. Centr. Bot. 3: 461. 1885.—*S. schaffneri* Boeck.
cyperoides Lam. Fl. Fr. 3: 553. 1778.—*S. maritimus* L.
cyperoides L. Mant. 2: 181. 1771.—*Cyperus cyperoides* (L.) O. Ktze.
cyperoides (R. Br.) Spreng. Syst. Veg. 1: 208. 1825.—*S. brunonianus* S. T. Blake

debilis Lam. Illustr. 1: 141. 1791.—*Fimbristylis ferruginea* (L.) Vahl
debilis (Kunth) O. Ktze. Rev. Gen. Pl. 1: 757. 1891.—*Eleocharis debilis* Kunth
debilis Pursh, Fl. Am. Sept. 1: 55. 1814.—*S. smithii* var. *williamsii* (Fern.) Beetle
var. *williamsii* Fern. Rhodora 3: 252. 1901.—*S. smithii* var. *williamsii* (Fern.) Beetle
decipiens St. Hill. in Nees, in Mart. Fl. Bras. ed. 2; 1: 208. 1840.—*S. californicus* (Mey.) Steud.
decumanus Willd. in Kunth, Enum. Pl. 2: 168. 1837, nomen.—*S. robustus* Pursh.
delicatulus Levyns, Jour. South Afr. Bot. 10: 30. 1944.
densus Wall. in Roxb. Fl. Ind. ed. Carey 231. 1832.—*Bulbostylis densa* (Wall.) Beetle
denudata (R. Br.) Poir. Encyc. Meth. Suppl. 5: 99. 1817.—*Fimbristylis denudata* R. Br.
depauperatus Komarov, Acta Hort. Petrop. 20: 345. 1902.
depauperatus Muhl. in Link, Jahrb. de Gew. 1: 79. 1820.
depauperatus (R. Br.) Poir. Encyc. Meth. Suppl. 5: 98. 1817.—*Fimbristylis diphylla* (Retz.) Vahl
depressus Velloz. Fl. Fuminensis 35, t. 38. 1827.—*Eleocharis geniculata* (L.) R. & S.
deserticola Phil. Fl. Atac. 53. 1860. (S. Am. # Monocephales)
var. *semisubterraneus* (Boeck.) Barros, Anal. Mus. Arg. Cienc. Nat. 38: 156. 1935.—*S. semisubterraneus* Boeck.
desprauxii Steud. Syn. Pl. Glum. Pars II. Cyp. 86. 1855.—*S. littoralis* Schrad.
desvauxii Phil. Anal. Univ. Chile 93: 482. 1896.
deustus Berg. Descr. Pl. Cap. Bonae Spei 10. 1767 (fide Kunth!)—*Ficinia trigyna* (L.) Pfeiff
diabolicus (Schrad.) Steud. Flora 12: 147. 1829. (# Isolepis)
dichotomus Bieb. Fl. Taur. Cauc. 1: 39. 1808.
dichotomus L. Sp. Pl. 1: 50. 1753.—*Fimbristylis diphylla* (Retz.) Vahl
dichotomus L. Sp. Pl. 2: 74. 1762.—*Fimbristylis dichotoma* (L.) Vahl
dichotomus G. F. Mey. Prim. Fl. Essequeboënsis 43. 1818.—*Fimbristylis spadicea* Vahl
dichotomus Willd. in Kunth, Enum. Pl. 2: 235, 239. 1837.—*Fimbristylis diphylla* (Retz.) Vahl

dichromenoides Clarke, Kew Bull. Add. Ser. 8: 89. 1908. (# Isolepis)
dictyospermus Wright in Sauv. Anal. Acad. Cienc. Habana 8: 79: 1871; Wright in Sauv. Fl. Cub. 75. 1871.—*Eleocharis cellulosa* Torr.
didymostachyus Phil. Anal. Univ. Chile 93: 475. 1896.—*S. inundatus* (R. Br.) Spreng.
dictrichiae Boeck. Flora 58: 109. 1875.
digitatus (Nees) Boeck. Linnaea 36: 691. 1870.—*S. rubicundus* (Nees) Parl.
var. *abbreviatus* Boeck. Linnaea 36: 691. 1870.—*S. rubicundus* (Nees) Parl.
divecus (Kunth) Boeck. Linnaea 36: 719. 1870.
var. *macrocephalus* Boeck. Linnaea 36: 720. 1870.
diphyllus Retz. Obs. 5: 15. 1789.—*Fimbristylis diphylla* (Retz.) Vahl
dipsaceus Rottb. Desc. Nov. Pl. 56. 1773.—*Fimbristylis dipsacea* (Rottb.) Benth. & Hook.
dipsaceus Vahl in Kunth, Enum. Pl. 2: 204. 1837.—*S. hystrix* Thunb.
dissachanthus Blake, S. T. Victorian Nat. 63: 116-120. 1946.
dissitus Duthie, Saharumpore Report 1885.—*Nomochloa compressa* (L.) Beetle
distichophyllus Boeck. Cyper. Nov. pt. 1, 19. 1888.—*S. atacamensis* (Phil.) Boeck.
distichus Peterm. Flora 27: 343. 1844.—*Nomochloa compressa* (L.) Beetle
divaricatus Ell. Sk. Fl. S. Car. 1: 88. t. 2. f. 4. 1816. (N. Am. # Androcoma)
dombeyanus (Kunth) O. Ktze. Rev. Gen. Pl. 1: 757. 1891.—*Eleocharis dombeyana* Kunth
domingensis Ham. Prod. Fl. Ind. Occ. 14. 1825.
domingensis Pers. Syn. Pl. 1: 67. 1805.—*Fimbristylis spadicea* f. *domingensis* (Pers.) Kük.
donianus Spreng. Syst. Veg. 4. cur. post. 28. 1827.—*S. quadrangulus* Don
dregeanus Clarke, in Dyer, Fl. Cap. 7: 224. 1898. (# Isolepis)
drepanensis Lojac. Fl. Sic. 3: 215. 1909.
drummondii Steud. Syn. Pl. Glum. Pars. II. Pars. II. Cyp. 318. 1855.—*S. lineatus* Michx.
dubius Roxb. Hort. Beng. 81. 1814, nomen; Fl. Ind. ed. Carey & Wall. 1: 218. 1820; Fl. Ind. ed. Carey 1: 215. 1832.—*Eleocharis*
dussianus Boeck. in Duss. Ann. Inst. Col. Marsille 3: 548. 1897.
dussii Boeck. Cyp. Nov. pt. 1, 19. 1888; Boeck. Cyp. Nov. pt. 2, 1890.
duvalii Hoppe in Sturm. Deutschl. Fl. Heft. 9: 36. 1814.—*S. lacustris* L. var. *tabernaemontani* (Gmel.) Doell

ebenocarpus Kirk, Trans. N. Zel. Inst. 17: 224. 1885.—*S. antarcticus* L.
echinatus L. Sp. Pl. 1: 50. 1753.—*Cyperus paniceus* (Rottb.) var. *roxburghianus* (Clarke) Kük.
echinatus Muhl. Desc. Gram. 39. 1817.—*Mariscus ovularis* Vahl
eckloneus Steud. Flora 12: 148. 1829.—*Ficinia ecklonea* (Steud.) Nees
edwallianus Boeck. Kjoeb. Vidensk. Meddel. 238. 1895.
effusus Gueldenst. Reisen 2: 179; Gueldenst. in Ledeb. Fl. Ross. 4: 252. 1853, nomen.
ehrenbergii Boeck. Linnaea 36: 716. 1870.—*S. maritimus* L.
elatus Boeck. Linnaea 36: 694. 1870.—*Ficinia tenuifolia* Kunth
elatus Gueldenst. Reisen 1: 22; Gueldenst. in Ledeb. Fl. Ross. 4: 252. 1853.
elatus (R. Br.) Poir. Encyc. Meth. Suppl. 5: 99. 1817.—*Fimbristylis denudata* R. Br.
elegans H.B.K. Nov. Gen. et Sp. 1: 226. 1816.—*Eleocharis geniculata* (L.) R. & S.
elegans Salisb. Prod. 31. 1796.—*Cyperus luzulae* (L.) Retz.
elegantulus Steud. Syn. Pl. Glum. Pars. II. Cyp. 317. 1855.—(excl. var.)—*Eleocharis obtusa* (Willd.) Schultes
var.? Steud. Syn. Pl. Glum. Pars. II. Cyp. 317. 1855.—*Eleocharis dombeyana* Kunth
elichnarius Molina Chile (ed. Angl.) (see *elychniarius*)
elliotii Spreng. Syst. Veg. 4: cur. post. 28. 1827.—*Fimbristylis diphylla* (Retz.) Vahl
ellipticus Muhl. in Link, Jahrb. de Gew. 1: 77. 1820.—*S. clintonii* Gray?
ellipticus Willd. in Kunth, Enum. Pl. 2: 146. 1837.—*Eleocharis elliptica* Kunth
elychniarius Mollina, Sagg. Chil. 129. (S. Am. # Holoschoenus)
elongatus Buch.-Ham. in D. Don. Prod. Fl. Nep. 40. 1825.—*Eriophorum comosum* (Wall.) Wright

elongatus Poir. Encyc. Meth. Suppl. 5: 99. 1817.—*Fimbristylis diphylla* (Retz.) Vahl
emarginatus (Kl.) O. Ktze. Rev. Gen. Pl. 1: 757. 1891.—*Eleocharis marginata* Klotzsch.
emergens (Norman) Fern. Rhodora 45: 281. 1943.—*S. pumilus* Vahl var. *emergens* (Norman) Beetle
equitans Kük. Wiss. Ergebn. Schwed. Rhod-Kongo-Exped. 1911-12, i. 7. 1921.
equisetoides Ell. Sk. Fl. S. Car. 1: 79. 1816.—*Eleocharis equisetoides* (Ell.) Torr.
equisetiformis Meinsch. Acta Hort. Petrop. 18: 261. 1900.—*Eleocharis*
erectogracilis Hayata, Ic. Pl. Formos. 6: 114. 1916.
erectus Poir. Encyc. Meth. 6: 761. 1804. (Asia & Hawaiian Islands # Actaeogeton)
  var. *debilis* Lecompte, Fl. Generale de L'Indo-Chine 7: 136. 1912.
  var. *wallichii* (Nees in Wight) Beetle, Am. Jour. Bot. 29: 654. 1942. (China & India # Actaeogeton)
eriophorum Kunth, Enum. Pl. 2: 170. 1837.—*S. cyperinus* var. *laxus* (Gray) Beetle
eriophorum Michx. Fl. Bor. Am. 1: 33. 1803.—*S. cyperinus* (L.) Kunth var. *eriophorum* (Michx.) O. Ktze.
  var. *andrewsii* Fern. Prod. Am. Acad. 34: 501. 1899.
  var. *condensatus* Fern. Proc. Am. Acad. 34: 501. 1899.—*S. cyperinus* (L.) Kunth f. *cephaloideus* (Sheldon) Beetle
  var. *cyperinus* Gray, Man. ed. 2. 501. 1856.—*S. cyperinus* (L.) Kunth
  var. *laxus* Gray, Man. ed. 2, 501. 1856.—*S. cyperinus* (L.) Kunth var. *laxus* (Gray) Beetle
eriophorus Poeppig. in Presl, Oken Isis 21: 269. 1828.—*S. stramineus* Presl
erraticus Rota in De Notaris, Ann. Sci. Nat. Ser. 3, 5: 366. 1846; Linnaea 19: 398. 1847.—*Eleocharis atropurpurea* (Retz.) Kunth
erythropodus (Steud.) O. Ktze. Rev. Gen. Pl. 1: 757. 1891.—*Eleocharis erythropoda* Steud.—*S. etuberculatus* (Steud.) O. Ktze. Acc. Index Kewensis
esculentus Fairchild, The World was My Garden 156. 1938.—*Eleocharis*
etuberculatus (Steud.) Fernald, Rhodora 8: 162. 1906.—*S. etuberculatus* (Steud.) O. Ktze.
etuberculatus (Steud.) O. Ktze. Rev. Gen. Pl. 1: 758. 1891. (N. Am. # Schoenoplectus)
eupaluster Lindb. f. Acta Soc. Faun. Fl. Tenn. 23: No. 7: 4. 1902.—*Eleocharis palustris* (L.) R. & S.
ewersmanni Fisch. in Meinsch. Acta Hort. Petrop. 18: 253. 1900; Fisch. in Litw. Acta Hort. Petrop. 40: 271. 1929, nomen in synon. *S. ehrenbergii.*—*S. maritimus* L.
exaltatus Pursh, Fl. Am. Sept. 1: 56. 1814.—*S. polyphyllus* Vahl
  var. *viviparus* Pursh, Fl. Am. Sept. 56. 1814; Ell. Sk. Fl. S. Car. 1: 88. 1816.—*S. polyphyllus* Vahl
excelsus Salisb. Prod. 31. 1796.—*Cladium germanicum* Schrad.
exiguus Griseb. Fl. Br. W. Ind. 569. 1864.—*Eleocharis minima* var. *bicolor* (Chapman) Svenson
exiguus H.B.K. Nov. Gen. et Sp. 1: 225. 1816.—*Eleocharis exigua* (H.B.K.) R. & S.
exilis Willd. in Poir. Encyc. Meth. 8: 105. 1817.—*Fimbristylis exilis* (Willd.) R. & S.
expallescens (Kunth) Boeck. Linnaea 26: 509. 1870.—*S. setaceus* L.
  var. *humilis* Boeck. Linnaea 26: 509. 1870.
expansus Fern. Rhodora 45: 293. 1943.—*S. sylvaticus* var. *bissellii* Fern.
  f. *bissellii* Fern. Rhodora 45: 294. 1943.—*S. sylvaticus* var. *bissellii* Fern.
  f. *globulosus* Fern. Rhodora 45: 294. 1943.—*S. sylvaticus* var. *bissellii* Fern.

falcatus Vahl, Enum. Pl. 2: 275. 1806.—*Fimbristylis junciformis* (H.B.K.) Lindm.
falsus Clarke in Dyer, Fl. Cap. 7: 230. 1898.
fascicularis St. Vincent. in Link, Jahrb. de Gew. 1: 78. 1820, nomen.
fastigiatus Thunb. Prod. Pl. Cap. 18. 1794.—*Ficinia fastigiata* Nees
fernaldi Bickn. Torreya 1: 96. 1901.—*S. martimus* L. var. *fernaldi* (Bickn.) Beetle
ferrugineus L. Sp. Pl. 1: 50. 1753; L. Sp. Pl. 2: 74. 1762.—*Fimbristylis ferruginea* (L.) Vahl
festucoides Poir. Encyc. Meth. 6: 752. 1804.—*Bulbostylis festucoides* (Poir.) Clarke

ficiniaeformis Boeck. in Rehm. Pl. exsicc. n. 72. acc. Clarke in Dur. & Schinz, Consp. Flor. Afr. 5: 617. 1895.—*S. antarcticus* L.
ficinioides Kunth, Enum. Pl. 2: 172. 1837.—*Ficinia tenuifolia* Kunth
filamentosus Vahl, Enum. Pl. 2: 262. 1806.—*Bulbostylis filamentosus* (Vahl) Clarke
filiculmis Schrad. in Griseb. Wiss. Goett. Abh. 24: 311. 1879.—*Eleocharis filiculmis* Kunth
var. *balanseanus* (Boeck.) Clarke in O. Ktze. Rev. Gen. Pl. 3: II. 336. 1898.
filiformis Burn. f. Fl. Cap. Prod. 3. 1768.—*Ficinia filiformis* (Burm. f.) comb. nov.
filiformis Lam. Illustr. 1: 138. 1791.—*Eleocharis capitata* (L.) R. Br.
filiformis Savi, Fl. Pisan. 1: 46. 1798.—*S. cernuus* Vahl
filipes Clarke, Jour. Linn. Soc. 36: 249. 1903. (Old World # Taphrogeton)
fimbriatus Boeck. Kjoeb. Vidensk. Meddel. 138. 1869; Boeck. Linnaea 36: 749. 1870.—*Fimbristylis*
fimbriatus Willd. in Kunth, Enum. Pl. 2: 235. 1837.—*Fimbristylis pilosa* (Thunb.) Vahl
fimbrisetus Delile, (Fl. Egypte 155. illus. 1813) Description de l'Egypte, Histoire Naturelle Tome II. p. 155, tab. VII, g. 1. Paris. 1826.—*S. litoralis* Schrad.
fimbristyloides K. Schum. in Clarke in Dyer, Fl. Trop. Afr. 8: 436. 1894.—*Bulbostylis schimperiana* (Hochst) Clarke
fistulosus Poir. Encyc. Meth. 6: 749. 1804.—*Eleocharis fistulosa* (Poir.) Link
fistulosus Forsk. Fl. Aegypt.-Arab. 14. 1775. (Afr. # Actaeogeton)
flaccidus Reichenb. in Weig. It. Pl. Surinam.; Reichenb. in Spreng. f. Tent. Suppl. Syst. 3. 1828.—*Eleocharis*
flaccifolius Steud. Syn. Pl. Glum. Pars. II. Cyp. 83. 1855.—*S. digitatus* (Schrad.) Boeck.?
flavescens Gronov. in Trautv. Acta Hort. Petrop. 9: 293. 1884, nomen.
flavescens Poir. Encyc. Meth. 6: 756. 1804.—*Eleocharis flavescens* (Poir.) Urb.
floccosus Griseb. Cat. Pl. Cub. 241. 1866.—*Bulbostylis floccosus* (Griseb.) Clarke
floridanus Michx. in Herb. Richard. acc. Kunth, Enum. Pl. 2: 158. 1837.—*Eleocharis parvula* (R. & S.) Link
fluitans L. Sp. Pl. 1: 48. 1753. (Old World # Eleogiton)
var. *emergens* Pfeiff. in Fedde, Repert. 33: 202. 1933.—*S. amazonicus* Beetle
var. *fasciculatus* Boeck. Linnaea 36: 486. 1870.
var. *microstachya* Benth. & Muell. Fl. Austral. 7: 325. 1878.
var. *robustus* Boeck. Linnaea 36: 486. 1870.—*S. striatus* (Nees) Fourcade
var. *spadiceus* Clarke, in Hook. f. Fl. Brit. Ind. 6: 653. 1893.
var. *stolonifer* Pers. Syn. Pl. 1: 66. 1805.—*S. fluitans* L.
var. *terrestris* Muell. in Benth. & Muell. Fl. Austral. 7: 325. 1878.
fluviatilis (Torr.) Gray, Man. 527. 1848; Gray, Man. Bot. N. U.S. ed. II 500. 1863. (N. Am. # Bolboschoenus)
foliatus Hook. f. in Hook. London Jour. Bot. 3: 414. 1844.—*Schoenus foliatus* (Hook. f.) S. T. Blake
fontinalis Harper, Bull. Torr. Bot. Club 30: 322. 1903. (N. Am. # Androcoma)
var. *virginiana* Fern. Rhodora 41: 532. 1939.
forsythii Kük. in Fedde, Repert. 12: 94. 1913.
fragrans Ruiz & Pav. Fl. Per. 1: 47. 1798.
frondosus Banks. & Soland. in Boeck. Flora 61: 141. 1878.—*Desmoschoenus*
fuegianus (Phil.) O. Ktze. Rev. Gen. Pl. 1: 757. 1891.—*Eleocharis fuegina* Phil.
fuirenoides Maxim. in C. B. Clarke, Jour. Linn. Soc. 36: 250. 1903; Maxim. Bull. Acad. Petersb. 31: 109. 1887. (Old World # Taphrogeton)
furvus Poir. Encyc. Meth. Suppl. 5: 99. 1817.—*Fimbristylis furva* R. Br.
fuscescens Link, Jahrb. de Gew. 1: 81. 1820.—*Fimbristylis dichotoma* Vahl
fuscosanguineus (Boeck.) O. Ktze. Rev. Gen. Pl. 1: 757. 1891.—*Eleocharis fuscosanguinea* Boeck.
fuscus Link, Jahrb. de Gew. 1: 79. 1820; Willd. in Kunth, Enum. Pl. 2: 212. 1837.—*Bulbostylis tenuifolia* (Rudge) Nees
fuscus Roxb. in Clarke in Hook. f. Fl. Brit. Ind. 6: 659. 1894.—*Fimbristylis compressa* Boeck.

gaillardii Maury in Morot. Jour. de Bot. 3: 197. 1889.—*Fimbristylis*
gaudichaudianus Kunth, Enum. Pl. 2: 157. 1837.—*Eleocharis flavescens* (Poir.) Urban
gaudichaudii (Kunth) Boeck. Linnaea 36: 511. 1870.—*S. inundatus* (R. Br.) Spreng. var. *tenuis* Boeck. Linnaea 36: 511. 1870.
geniculatus L. Sp. Pl. 1: 48. 1753.—*Eleocharis geniculata* (L.) R. & S. var. *minor* Vahl, Enum. Pl. 2: 251. 1806.—*Eleocharis geniculata* (L.) R. & S.
geniculatus Pursh, Fl. Am. Sept. 1: 55. 1814.—*Eleocharis interstincta* (Vahl) R. & S.
georgianus Harper, Bull. Torr. Bot. Club 27: 331. 1900.—*S. atrovirens* Willd.
germanicus (Palla) Aschers. & Graebn. in C. A. Lindm. Svensk. fanerogamfl. 117. 1918. —*S. cespitosus* L.
germanicus (Palla) W. Christensen in Schrift. Nat. Ver. Schleswig Holst. 21: 23. 1935.—*S. cespitosus* L.
giganteus Kunth, Enum. Pl. 2: 172. 1837. (S. Am. # Androcoma)
giganteus Noronha in Thouars, Prod. Phyt. 2, in Mélang 1811, nomen.
giraudyi (Steud.) Boeck. Linnaea 36: 483. 1870.—(# Eleogiton)
glaucescens Willd. Sp. Pl. 1: 76. 1809.—*Eleocharis palustris* (L.) R. & S. var. *glaucescens* (Willd.) Gray
glaucophyllus Boeck. Kjoeb. Vidensk. Meddel. 153. 1871.—*Fimbristylis glaucophyllus* (Boeck.) Comb. Nov.
glaucovirens (Boeck.) O. Ktze. Rev. Gen. Pl. 1: 757. 1891.—*Eleocharis glaucovirens* Boeck.
glaucus Lam. Illustr. 1: 142. 1791.—*S. maritimus* L.
glaucus Nees & Meyen, Linnaea 9: 293: 1834, nomen—*S. asper* Presl.
glaucus Sm. Engl. Bot. t. 2321. 1811.—*S. lacustris* L.
glaucus Torr. Fl. No. & Midl. U. S. 44. 1824.—*Eleocharis calva* Torr.
glaziovii Boeck. Kjoeb. Vidensk. Meddel 152. 1871; Boeck. Linnaea 38: 379. 1874.—*Bulbostylis glaziovii* (Steud.) Clarke
glehni Meinsch. in Komarov, Acta Hort. Petrop. 39: 34. 1923, nomen.—*Eleocharis kamtschatica* (Mey.) Kom.
globiceps Clarke in Dur. & Schinz. Consp. Fl. Afr. 5: 622. 1895.—*S. rubicundus* (Nees) Parl.
globifer Welw. in Steud. Syn. Pl. Glum. Pars II. Cyp. 87. 1855.—*S. lacustris* L.
globiferus Linn. f. Suppl. 104. 1781.—*S. holoschoenus* L.
globosus Spreng. in R. & S. Syst. Veg. 3: 535. 1817; Syst. Veg. 4. cur. post. 27. 1827. —*S. nodosus* Rottb.
globulosus Retz. Obs. 6: 19. 1791.—*Fimbristylis globulosa* (Retz.) Kunth
globulosus Roxb. Hort. Beng. 81. 1814; Roxb. Fl. Ind. ed. Carey & Wall. 1: 217. 1820. —*Fimbristylis ferruginea* (L.) Vahl
glomeratus Heyne in Wall. Cat. No. 3460. 1828.—*Cyperus arenarius* Retz.
glomeratus L. Sp. Pl. 1: 52. 1753.—*Cyperus dubius* Rottb. and pro parte *C. brevifolius* (Rottb.) Hassk. (teste Clarke). Also—*Mariscus niveus* (Murr.) Murr. acc. Mert. Enum. Phil. Plants 1: 113. 1922.
glomeratus Retz. Obs. Bot. 4: 11. 1786.—*Fimbristylis spathacea* Roth
glomeratus Roxb. Fl. Ind. ed. Carey & Wall. 1: 224. 1820.—*Fimbristylis diphylla* (Retz.) Vahl
glomeratus Scop. Fl. Carn. ed. II. 1: 47. 1772.—*S. mucronatus* L.
glutinosus Banks & Soland. in Hook. f. Handb. N. Zel. Fl. 1: 207. 1867.—*S. nodosus* Rottb.
"*gmelini* (Honck.) Verz. Aller. Gew. Teutschl. 138. (Quid?)—Europ." According to Index Kewensis
gracilis Koch in Salzm. Enum. Pl. Rar. Gall. 9. 1818.—*S. cernuus* Vahl
gracilis Nees in Kunth, Enum. Pl. 2: 585. 1837, nomen.—*Eleocharis maculosa* R. Br.
gracilis (R. Br.) O. Ktze. Rev. Gen. Pl. 757-58. 1891.—*Eleocharis*
gracilis Link, Jahrb. de Gew. 1: 81. 1820.—*Fimbristylis autumnalis* (L.) R. & S.
gracilis Poir. Encyc. Meth. 6: 763. 1804; Spreng. Flora 12: Beil. 11. 1829.—*Ficinia gracilis* Schrad.
gracilis Rudge, Trans. Linn. Soc. 10: 289. 1811.—*S. nodosus* Rottb.

gracilis Salzm. in Reichenb. Ic. Fl. Germ. 8: 37, fig. 698. 1846.—*Eleocharis carniolica* C. Koch
gracilis Willd. in Kunth, Enum. Pl. 2: 227. 1837, nomen—*Fimbristylis tenuis* R. & S.
gracilis Zeyh. in Kunth, Enum. Pl. 2: 256. 1837, nomen—*Ficinia gracilis* Schrad.
gracillimus Boeck. Linnaea 36: 761-62. 1870.—*Bulbostylis*
gracillimus Kohts, Oester. Bot. Zeitschr. 19: 333. 1869.—*S. setaceus* L.
gramineus Neck. Delic. Gallo-Belg. 27.—*S. sylvaticus* L.
grandis (Boeck.) O. Ktze. Rev. Gen. Pl. 1: 757. 1891.—*Eleocharis grandis* Boeck.
granulato-hirtellus Boeck. in Schinz, Verh. Bot. Ver. Brand. 31: 179. 1890.—*Fimbristylis exilis* (Willd.) R. & S.
griffithii Boeck. Flora 41: 595. 1858.—*S. grossus* L. f.
griquensium Clarke, in Dur. & Schinz. Consp. Flora. Afr. 5: 623. 1895, nomen. (# Isolepis)
grossus L. f. Suppl. 104. 1781. (Asia # Hymenochaeta)
var. *kysoor* (Roxb.) Clarke in Hook. f. Fl. Brit. Ind. 6: 600. 1894.—*S. grossus* L. f. f. *kysoor* (Roxb.) Beetle
f. *kysoor* (Roxb.) Beetle, Am. Jour. Bot. 33: 661. 1946 (Asia # Hymenochaeta)
gunnii (Steud.) Boeck. Linnaea 36: 493. 1870.—*S. inundatus* (R. Br.) Spreng.

habessinicus Ehrenb. in Boeck. Linnaea 37: 17. 1871, nomen in synon.—*Fimbristylis ferruginea* (L.) Vahl var. *sieberiana* (Kunth) Boeck.
hahnii Clarke, Kew Bull. add. ser. 8: 30. 1908. (Mexico)—*Cyperus* ?
hakonensis Fr. & Savat. Enum. Pl. Jap. 2: 110. 1879.—*Eleocharis tetraquetra* Nees
halleri L. in Jackson, Index Linn. Herb. 133. 1912, nomen nudum et dubium.
halleri Vill. Plant Dauph. 3: 188. 1787.—*Eleocharis pauciflora* (Lightf.) Link
halleri Vitm. Summa Pl. 1: 150. 1789.—*S. supinus* L.
hallii Gray, Man. Bot. N. U.S. addenda ed. 2. 1863; Gray, Trans. N. York Acad. Sci. 9: 11. 1889.—*S. supinus* L. var. *hallii* Gray
hamulosus Stev. Mem. Soc. Nat. Mosc. 5: 356. 1814.—*Cyperus hamulosus* M. Bieb.
hattorianus Makino, Jour. Jap. Bot. 8: 44. 1933.
helferi Beetle, Am. Jour. Bot. 33: 662. 1946. (India # Nemocharis)
hemisphaericus Roth, Nov. Pl. Sp. 29. 1821.—*Lipocarpha sphacelata* Kunth
heniuncialis Clarke in De Wildem. Pl. Nov. Hort. Then. 23. t. 6.
heterocarpus Wats. Proc. Am. Acad. 18: 171. 1883.—*Bulbostylis funckii* Clarke
heterochaetus Chase, Rhodora 6: 70. 1904. (N. Am. # Pterolepis)
heteromorphus Phil. f. Cat. Pl. Vasc. Chil. 311. 1881.—*Eleocharis melanostachys* (D'Urville) Clarke
hexatrichus Ehrenb. in Boeck. Linnaea 36: 453. 1870; Ehrenb. in Boiss. Fl. Orient. 5: 387. 1884.—*Eleocharis macrantha* Boeck.
hieronymi Boeck. Cyper. Nov. pt. 1, 18. 1888.—*S. atacamensis* (Phil.) Boeck.
hildebrandtii Boeck. Flora 58: 263. 1875.—*Fimbristylis exilis* (Willd.) R. & S.
hippolyti Krecz. in Not. Syst. Herb. Inst. Bot. Acad. Sci. U.R.S.S. 7: 28. 1937. (Russia)
hirsutus Willd. in Kunth, Enum. Pl. 2: 210. 1837, nomen.—*Fimbristylis hirtella* Vahl
hirtellus (Schrad.) Boeck. Linnaea 36: 765. 1870.—*Bulbostylis hirtella* (Schrad.) Urban
hirtus Griseb. Cat. Pl. Cub. 241. 1866.—*Bulbostylis vestita* (Kunth) Clarke
var. *hispida* Wright, in Sauv. Fl. de Cuba 176. 1871.
hirtus Poir. Ency. Meth. Suppl. 5: 106. 1817; Willd. in Kunth, Enum. Pl. 2: 224. 1837. —*Fimbristylis squarrosa* Vahl
hispanica Gueldenst. Reisen 1: 109.; Gueldenst. in Ledeb. Fl. Ross. 4: 252. 1853.
hispidulus Vahl, Enum, Pl. 2: 276. 1806.—*Fimbristylis exilis* (Willd.) R. & S.
hochstetteri Boeck. Linnaea 36: 739. 1870.—*Fimbristylis*
hokkaidoensis Beetle, Am. Jour. Bot. 33: 662. 1946 (Japan # Nemocharis)
holoscoenus L. Sp. Pl. 1: 49. 1753. (# Holoschoenus)
var. Y Parl. Fl. palermit. 1: 66. 1845.—*S. panormitanus* Parl. (which see).
var. *australis* Koch, Syn. Fl. Germ. ed. 2. 857. 1844.
c. *australis* Parl. Fl. Ital. 2: 96. 1852.

ssp. *eu-holoschoenus* Briq. Prod. Fl. Corse 1: 231. 1910.
var. *genuinus* Boiss. Fl. Orient. 5: 381-382. 1884.
var. *genuinus* Gren. & Godr. Fl. France 3: 372. 1855.
var. *globifer* Boiss. Pl. Orient. 5: 381-382. 1884.
b. *globiferus* Parl. Fl. Ital. 2: 96. 1852.
var. *linnaei* Aschers. & Graebn. Syn. Mitteleurop. Fl. 2: ab 2, 322. 1904.
var. *major* Celak. Prod. Fl. Böhn. 1: 76. 1867.
d. *romanus* Parl. Fl. Ital. 2: 97. 1852.
var. *thunbergii* (Schrad.) Clarke in Dur. & Schinz., Consp. Flor. Afr. 5: 623. 1895
var. *typicus* Fiori in Fiori & Paol. Fl. Anal. It. 1: 119. 1896.
var. *vulgaris* Koch, Syn. Fl. Germ. ed. 2, 857. 1844.
a. *vulgaris* Parl. Fl. Ital. 2: 95. 1852.

see: A. Becherer: Notes critiques sur le *Scirpus holoschoenus* L. Candollea 4: 130-145. 1929; and A. Hayek: Petite Contribution a la Flore de France Candollea 3: 479. 480. 1929.

holoschoenus Oed. Fl. Dan. t. 454. 1761.—*S. lacustris* var. *tabernaemontani* (Gmel.) Doell.

hondoënsis Ohwi, Bot. Mag. Tokyo 45: 189. 1931.

hookeri Kunth, Enum. Pl. 2: 173. 1837. (# Isolepis)

hookeri (Boeck.) O. Ktze. Rev. Gen. Pl. 1: 757. 1891.—*Eleocharis*

hoppi Weihe, Flora 11: 118. 1828.—*S. triqueter* L.

hotarui Ohwi in Fedde, Repert. 36: 44. 1934.

hottentottus L. Mant. 2: 82. 1771; illustr. in Rottb. Desc. Pl. Pl. XVI. 1773.—*Fuirena hottentotta* (L.) Druce

hudsonianus (Michx.) Fern. Rhodora 8: 161. 1906. (northern hemisphere # Baeothryon)

humberti Cherm. Bull. Soc. Bot. France 58: 422. 1921. (Afr. # Isolepis)

humboldtii A. Dietr. Sp. Pl. 2: 112. 1833.—*Hemicarpha micrantha* (Vahl) Pax

humboldtii Spreng. Syst. Veg. 1: 213. 1825. *Bulbostylis junciformis* (HBK) Lindman

humilis Link, Jahrb. de Gew. 1: 78. 1820.—*Bulbostylis tenuifolia* Nees

humilis Wallr. Sched. Crit. 27. 1822.—*Eleocharis parvula* (R. & S.) Link

humilis Willd. in Kunth, Enum. Pl. 2: 212. 1837, nomen—*Bulbostylis capillaris* (L.) Clarke

humillimus Benth. in Benth. & Muell. Fl. Austral. 7: 324. 1878. (Australia # Isolepis)

hyalinolepis Steud. in Jardin, Bull. Soc. Linn. Normand. Ser. II. 9: 278, 280. 1875.—*S. maritimus* L.

hystrix Thunb. Fl. *strengnesensis* 362. 1791; Prod. Pl. Cap. 17. 1794.

imberbis (R. Br.) Poir. Encyc. Suppl. 2: 251. 1817, neque (homonyma) p. 250, nec R. Br.—*Schoenus apogon* R. & S.

impar Ehrenb. in Boeck. Linnaea 36: 461-62. 1870.—*Eleocharis capitata* (L.) R. Br.

inanis (Thunb.) Steud. Syn. Pl. Glum. Pars. II. Cyp. 86. 1855.

inclinatus Aschers. & Schweinf. in Boiss. Fl. Orient. 5: 381. 1884. (Afr. # Actaeogeton)

incomtulus Boeck. Linnaea 36: 693. 1870. (# Isolepis)

inconspicuus Levyns, Jour. South Afr. Bot. 10: 30. 1944.

incurvatus Roxb. Hort. Beng. 6. 1814, nomen; Roxb. Fl. Ind. ed. Carey & Wall. 1: 216. 1820.—*S. articulatus* L.

interceptus Roxb. in Nees in Wight, Contrib. Pl. Ind. 114. 1834.—*Eleocharis dulcis* (Burm. f.) Trin.

interior Britton, Man. Fl. N. U.S. ed. 2. 178. 1905.—*S. paludosus* A. Nels.

intermedius Čelak. Arch. Naturw. Landesd. Boehm. 4: 742. 1881.—*S. sylvaticus* L. var. *pedicellatus* Peterm.

intermedius Gray in Torr. Ann. Lyc. N. York 3: 300. 1836.—*Eleocharis olivacea* Torr.

intermedius Muhl. Desc. Gram. 31. 1817.—*Eleocharis intermedia* (Muhl.) Schult.

intermedius Poir. Encyc. Meth. 4: 767. 1804.—*S. holoschoenus* L.

intermedius Thuill. Fl. Par. ed. 2. 21. 1824.—*Eleocharis palustris* (L.) R. & S.

interstinctus Poeppig. in Presl, Oken Isis 21: 269. 1828.—*Eleocharis geniculata* (L.) R. & S.

interstinctus Vahl, Enum. Pl. 2: 251. 1806.--*Eleocharis interstincta* (Vahl) R. & S.
intricatus L. Mant. 2: 182. 1771.—*Cyperus aristatus* Rottb.
inundatus (R. Br.) Spreng. Syst. Veg. 1: 207. 1825. (# Isolepis)
var. *floribundus* Benth. in Benth. & Muell. Fl. Austral. 7: 329-330. 1878.
var. *gracillima* Cheesman, Man. N. Zeal. Fl. 775. 1906.
var. *major* Cheesman, Man. N. Zeal. Fl. 775. 1906.
iridifolius Bory, Boy. 2: 94. 1804; Poir. Encyc. Meth. 6: 783. 1804.—*Cladium iridifolium* (Bory) Baker
isdellensis Fitzg. Jour. Roy. Soc. W. Austral. 3: 123. 1918.
isolepis (Nees) Boeck. Linnaea 36: 498. 1870. (# Isolepis)

jacobi Fisch. Kew. Bull. 103. 1931. (India # Actaeogeton)
jaluanus Nakai in Mori, Enum. Pl. Cor. 77. 1922, nomen. (Corea)
janii Bess in Schult. in R. & S. Syst. Veg. 2: mant. 536. 1824.—*S. lacustris* L. var. *tabernaemontani* (Gmel.) Doell.
japonicus (Miq.) E. & Savat. Enum. Pl. Jap. 2: 909. 1879.—*Eleocharis pellucida* Presl
var. *thermalis* Hulten, Fl. Kamtschatka 1: 165, t. 5 e. 1928.—(?) *Eleocharis laeviseta* Nakai
japonicus (Boeck.) O. Ktze. Rev. Gen. Pl. 1: 757. 1891.—*Eleocharis japonicus* Boeck.
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javanus Nees in Wight, Contrib. Pl. Ind. 112. 1834.—*S. mucronatus* L.
junceus Forst. f. Prod. Fl. Ins. Aust. 6. 1779.—*Fimbristylis juncea* (Forst.) R. Br.
junciformis Link, Jahrb. de Gew. 1: 81. 1820.—*Bulbostylis junciformis* (H.B.K.) Lindm.
junciformis Nees in Wight, Contrib. Pl. Ind. 112. 1834.—*S. erectus* Poir.
junciformis (H.B.K.) Poir. Encyc. Meth. Suppl. 5: 105. 1817.—*Bulbostylis junciformis* (H.B.K.) Lindm.
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juncoides Roxb. Hort. Beng. 81. 1814, nomen; Roxb. Fl. Ind. ed. Carey & Wall. 1: 216. 1820.—*S. erectus* Poir.
juncoides Willd. in Kunth, Enum. Pl. 2: 211. 1837.—*Bulbostylis junciformis* (H.B.K.) Lindman
var. *nanus* Griseb. Pl. Lorentz. 219. 1874.—*Bulbostylis juncoides* (Vahl) Kük. var. *nana* Griseb. in Barros
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kallii 3 *alpini* Forsk. Fl. Aegypt.-Arab. 15. 1775.—*Cyperus capitatus* Vandelli
kalmusi Aschers. Abrom. & Graebn. in Aschers. & Graebn. Fl. Nordostd. Flach. 133. 1898.—*S. lacustris* var. *tabernaemontani* (Gmel.) Doell.
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kochii Maiden & Betchie, Proc. Linn. Soc. New S. Wales 33: 318. 1908. (# Isolepis)
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kysoor Roxb. Hort. Beng. 6. 1814, nomen; Fl. Ind. ed. Carey & Wall. 1: 235. 1820.—*S. grossus* L. f. f. *kysoor* (Roxb.) Beetle
kysooroides Griff. Itin. Notes (Posth. papers 2) 155, no. 765. 1848, nomen subnudum.

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laciniatus Nees & Ehrenb. in Boeck. Linnaea 36: 459. 1870.—*Eleocharis atropurpurea* Kunth
laciniatus Thunb. Prod. Pl. Cap. 17. 1794.—*Ficinia laciniata* (Thunb.) Nees
lacuster of authors—*S. lacustris* L.
lacustris L. Sp. Pl. 1: 48. 1753. (Old World # Pterolepis)
var. *bodamicus* Reichenb. Ic. Fl. Germ. 8: 41. 1846.
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var. *confertus* Schur, Enum. Pl. Transs. 692. 1866.
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var. *genuinus* Gren. & Godr. Fl. France III. 372. 1855.—*S. lacustris* L.
subsp. *glaucus* Hartm. Svensk. Og Norsk Exc. Fl. 10. 1846.—*S. lacustris* var. *tabermontani* (Gmel.) Doell.
var. *glaucus* Boeck. Linnaea 36: 713. 1870.—*S. lacustris* var. *tabernaemontani* (Gmel.) Doell.
var. *medius* Rochel pl. exsicc. fid. Besser in lit. acc. Roem. & Schult. Syst. Veg. 3: 537. 1827.—*S. lacustris* var. *tabernaemontani* (Gmel.) Doell.
var. *minor* Doell. Rhein. Fl. 165. 1843.
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var. *minimus* Schur. Enum. Pl. Transs. 693. 1866.
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subsp. *tabernaemontani* Syme, Eng. Bot. 3, ed. 10. 63. 1870.—equals following.
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laeteflorens Clarke in Dur. & Schinz. Consp. Fl. Afr. 5: 644. 1895, nomen.
laetevirens Schrad. in Nees in Mart. Fl. Bras. 2: 1. 103. 1842.—*Eleocharis atropurpurea* Kunth
laevis S. T. Blake, Proc. Roy. Soc. Queensl. 51. 177. 1940 (# Isolepis)
lagoensis Boeck. Cyper. Nov. pt. 2, 15. 1890.
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lanceaeglumis Clarke in Dur. & Schinz. Consp. Fl. Afr. 5: 634. 1894, nomen.—*S. varius* Boeck.
laniferus Boeck. Linnaea 36: 768. 1870.—*Bulbostylis lanifera* (Boeck.) comb. nov.
lappaceus Lam. Illustr. 1: 139. 1791.—*Cyperus aristatus* Rottb.
lateralis Forsk. Fl. Aegypt-Arab. 15. 1775.—*S. supinus* L.
lateralis Retz. Obs. 4: 12. 1786.—*S. erectus* Poir.
lateriflorus Gmel. Syst. Veg. 1: 127. 1796.—*S. erectus* Poir.

latifolius Bertol. in Bologn. Opus Sc. 3: 406. 1819.—*Pleurostachys tenuiflora* Brongn.
latifolius Gilib. Exercit. 2: 515. 1792.—*S. sylvaticus* L.
lavarum Poir. Encyc. Meth. 6: 783. 1804.—*Cladium iridifolium* (Bory) Baker
lawianus Boeck. Linnaea 36: 497. 1870.—*Fimbristylis digitata* Boeck.
laxiflorus Steud. Syn. Pl. Glum. Pars II. Cyp. 166. 1855.—*Schoenus apogon* R. & S.
laxiflorus Thw. in Clarke, Contrib. U. S. Natl. Herb. 10: 455. 1908.—see following.
laxiflorus Thw. Enum. Pl. Zeyl. 435 1864.—*Eleocharis laxiflora* (Thw.) H. Pfeiff. acc. to S. T. Blake, Jour. Arn. Arb. 28: 227. 1947.
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laxus Poir. Encyc. Meth. Suppl. 5: 101. 1817.—*Fimbristylis diphylla* (Retz.) Vahl
lechleri (Boeck.) O. Ktze. Rev. Gen. Pl. 1: 757. 1891.—*Eleocharis lechleri* Boeck.
lehmanni Kierulff in Bunge, Reliquiae Lehm. p. (517) 341.—see Meinsch. Act. Hort. Petrop. 18: 261. 1900.—*Eleocharis*
leiocarpus (Miq.) Meinsch. Acta Hort. Petrop. 18: 249. 1900.—*Fimbristylis leiocarpa* Miq.
lejeunei Weihe, Flora 11: 116. 1828.—*S. triqueter* L.
lemburgensis Schult. in R. & S. Syst. Veg. 2: mant. 85. 1824.—*S. limburgensis* Lej.
lenticularis Poir. Encyc. Meth. Suppl. 5: 103. 1817; Spreng. Syst. Veg. 1: 208. 1825. (# Eleogiton)
lenticularis Torr. Ann. Lyc. N. York 3: 328. 1836.—*S. microcarpus* Presl
leptaleus Koch, Syll. Ratisb. 1: 8. 1824.—*S. cernuus* Vahl
leptalius Koch, Flor. App. 8. 1821.—*S. cernuus* Vahl
leptocarpus Muell. Trans. Phil. Soc. Vict. 1: 109. 1855.—*Lipocarpha microcephala* Kunth
leptolepis Chapm. Fl. S. U.S. 520. 1860.—*S. etuberculatus* (Steud.) Ktze.
leptopus Boeck. Flora 41: 414. 1858.—*Cyperus xanthostachyus* Steud.
leptos Wright in Sauv. Fl. Cuba 176. 1871; Wright in Sauv. Anal. Acad. Cienc. Habana 8: 81. 1871.—*Eleocharis leptos* (Steud.) Svenson
leptostachyus (Kunth) Boeck. Linnaea 36: 485. 1870. (Afr. # Eleogiton)
lereschii Thom. in Koch, Syn. Fl. Germ. ed. II. 853. 1844; Thom. in Parl. Fl. Ital. 2: 68. 1852, nomen; Thom. Cat. Pl. Swiss. 44. 1837, nomen.—*Eleocharis atropurpurea* (Retz.) Kunth
leucanthus Boeck. Verh. Bot. Ver. Brand. 29: 46. 1888.—*S. supinus* L.
leucocoleus K. Schum. Engl. Pflanzenw. Ost.-Afr. 5: 125. 1895.—*Ficinia filiformis* (Lam.) Schrad.
leucostachyus Link, Jahrb. de Gew. 1: 81. 1820.—*Bulbostylis leucostachya* (H.B.K.) Clarke
leucostachyus (H.B.K.) Poir. Encyc. Meth. Suppl. 5: 104. 1817.—*Bulbostylis leucostachya* (H.B.K.) Clarke
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limburgensis Lej. Fl. Spa. 2: 289. 1813.—*Eleocharis palustris* (L.) R. & S.
limensis Clarke, Kew. Bull. Add. ser. 8: 29. 1908.—*S. americanus Pers.* var. *longisetis* (Benth. & Muell.) Beetle
limosus Schrad. Goett. de Anz. 3: 2069. 1821; Schrad. Anal. Fl. Cap. 129, t. 2. fig. 1. 1821.—*Eleocharis limosa* (Schrad.) Schultes
lineatus Michx. Fl. Bor. Am. 1: 32. 1803. (N. Am. # Androcoma)
haberi House, Bull. N. Y. State Mus. 176. 38. 1915.
f. *elongatus* Eames, Rhodora 33: 168. 1931.
lineatus Muhl. Desc. Gram. 45. 1817.—*S. divaricatus* Ell.
lineolatus Fr. & Savat. Enum. Pl. Jap. 2: 545. 1879.—*S. erectus* Poir.
liocarpus (Phil.) O. Ktze. Rev. Gen. Pl. 1: 757. 1891.—*Eleocharis liocarpa* Phil.
lithosperma Noronha in Thouars, Prod. Phyt. 2, in Mélang. 1811, nomen.

lithospermus L. Sp. Pl. 1: 51. 1753.—*Scleria lithosperma* (L.) Sw.
lithuanicus Bess in Schult. in R. & S. Syst. Veg. 2: Mant. 535. 1827.—*S. lacustris* L.
litoralis (Phil.) O. Ktze. Rev. Gen. Pl. 1: 757. 1891.—*Eleocharis litoralis* Phil.
littoralis Fluegge in Reichenb. Fl. Germ. Excurs. 74. 1830-32.—*Nomochloa rufa* (Schrad.) Beetle
littoralis Schrad. Fl. Germ. 1: 142. t. 5, f. 7. 1806; Schrad. in Kunth, Enum. Pl. 2: 166. 1837. (Old World # Pterolepis)
var. *oligostachys* Boiss. Fl. Orient. 5: 384. 1884.—*S. littoralis* Schrad.
var. *pterolepis* (Kunth) Clarke in Dur. & Schinz, Consp. Fl. Afr. 5: 625. 1895.—*S. pterolepis* Kunth
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loefgrenii Boeck. Cyp. Nov. 2: 16. 1890.
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longevaginatus Boeck. Cyp. Nov. 2: 16. 1890.
longibracteatus Salzm. in Reich. Flora 497. 1830.—*S. holoschoenus* L.
longifolius Hook. & Arn. Bot. Beech. Voy. 49. 1841.—*S. americanus* Pers. var. *polyphyllus* (Boeck.) Beetle
longifolius Rich. Act. Soc. Hist. Nat. Par. 1: 106. 1792.—*Hypolytrum longifolium* Nees
longii Fernald, Rhodora 13: 6. 1911. (N. Am. # Eriophorum)
longispicatus Smyth, Trans. Kansas Acad. Sci. 16: 163. 1899.—*S. americanus* Pers.
lorentzii Boeck. Linnaea 38: 378. 1874.—*Bulbostylis juncoides* (Vahl) Kük. var. *lorentzii* (Boeck.) Kük.
lucidus Less. in Kunth, Enum. Pl. 2: 168. 1837, nomen.—*S. strobilinus* Roxb.
ludwigii (Steud.) Boeck. Linnaea 36: 486. 1870 (# Eleogiton)
lugardi Clarke in Dyer. Fl. Trop. Afr. 8: 458. 1894 (Afr.)
lupulinus Spreng. Fl. Hal. Mant. 30. 1807.—*Cyperus filiculmis* Vahl var. *macilentus* Fern.
lupulinus (Nees) Roshev. in Komarov. Fl. U. S. S. R. 3: 53. 1935.—*S. roylei* (Nees) Beetle
lushanensis Ohwi, Acta Phytotax & Geobot., Kyoto 7: 134. 1938. (China)
luteus Gilib. Exercit. 2: 513. 1792.—*S. cespitosus* L. var. *callosus* Bigel.
luzonensis Presl, Rel. Haenk. 1: 193. 1828. (# Actaeogeton)
luzulae L. Syst. ed. 10: 868. 1759; L. Sp. Pl. ed. 2. 75. 1762.—*Cyperus luzulae* (L.) Retz.
luzulinus Reichenb. in Kunth, Enum. Pl. 2: 211. 1837.—*Bulbostylis junciformis* (H.B.K.) Lindm.
lyallii Baker, Jour. Linn. Soc. 20: 297. 1883.—*S. inclinatus* Aschers. & Graebn.

macer Boeck. Engl. Bot. Jahrb. 5: 503. 1884.—*S. costatus* var. *macer* H. Cherm.
macounii Holm. Am. Jour. Sci. 21: 168. 1904.—*S. microcarpus* Presl
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macrolepis Boeck. in Clarke, in Dur. & Schinz, Consp. Fl. Afr. 5: 614, 616. 1895.—*Bulbostylis kirkii* Clarke
macrolepis Phil. Anal.. Univ. Chile 93: 481. 1896. (S. Am. # Monocephales)
macrophyllus Wolfgang in Reichenb. Icon. Fl. Germ. 8: 42. 1846, nomen.—*S. lacustris* L. var. *tabernaemontani* (Gmel.) Doell.
macrophyllus Bess in Schult. in R. & S. Syst. Veg. 2: mant. 535, in obs. 1824.—*S. lacustris* L.
macrostachyos Lam. Illustr. 1: 142. 1791.—*S. maritimus* L.
macrostachys Boeck. Cyper. Nov. 1: 19. 1888.
macrostachys Muhl.; Spreng. Syst. 1: 211. 1817.—*S. robustus* Pursh
macrostachys Willd. Enum. Hort. Berol. 78. 1809.
macrostylis Spreng. Syst. Veg. 1: 208. 1825.—*Rynchospora pterocarpa* R. & S.

maculosus (R. Br.) O. Ktze. Rev. Gen. Pl. 1: 757-758. 1891.—*Eleocharis maculosa* (Vahl) R. & S.

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margaritiferus (Nees) Boeck. Linnaea 36: 697. 1870.—*Schoenus apogon* R. & S.

marginatus Muhl. Desc. Gram. 28. 1817.—*Eleocharis quadrangulata* (Michx.) R. & S.

marginatus Thunb. Prod. Pl. Cap. 17. 1794.—*Ficinia filiformis* (Lam.) Schrad.

marginulatus (Hochst.) O. Ktze. Rev. Gen. Pl. 1: 757-58. 1891.—*Eleocharis marginulata* Hochst.

maritimus L. Sp. Pl. 1: 51. 1753. (N. Hemisph. & Austral. # Bolboschoenus)

var. *aemulans* Miq. Fl. Ind. Bot. 3: 306. 1859.—*S. grossus* L. f.

var. *affinis* Clarke in Hook. f. Fl. Brit. Ind. 6: 659. 1894.—*S. strobilinus* Roxb.

var. *agonus* (Fern.) Beetle, Leafl. West. Bot. 4: 46. 1944. (N. Am.)

var. *amentiferus* Ridl. Trans. Linn. Soc. Ser. II. 7: 158. 1884.

var. *barbatulus* Peterm. Flora 27: 342. 1844.

var. *compactus* Koch in Reichenb. Ic. Fl. Germ. 8: 43. 1846; Koch, Syn. Pl. Germ. et Helv. III. 1: 645. 1857.—*S. tuberosus* Desf.

var. *cylindricus* Torr. New York Acad. Sci. (Ann. Lyc. Nat. Hist. N. Y.) 3: 325. 1836.—*S. etuberculatus* (Steud.) O. Ktze.

var. *cylindricus* Wight, Contrib. Bot. Ind. III. 1834.—*S. maritimus* L.

var. *cymosus* Reichenb. Fl. Germ. 79. 1830-32.—*S. maritimus* L.

var. *digynus* Boeck. Linnaea 36: 723. 1870.—*S. strobilinus* Roxb.

var. *digynus* Hillebrand, Fl. Hawaiian Isl. 475. 1888.—*S. paludosus* var. *digynus* (Hillebrand) Beetle

var. *fernaldi* (Bicknell) Beetle, Amer. Jour. Bot. 29: 85. 1942 (N. Am.)

var. *fernaldi* f. *agonus* Fernald, Rhodora 45: 288. 1943.—*S. maritimus* L. var. *agonus* (Fern.) Beetle

var. *fluviatilis* Torr. Ann. Lyc. N. Y. 3: 325. 1836; Boeck. Linnaea 36: 723. 1870.—*S. fluviatilis* (Torr.) Gray

var. *glaucus* Wight, Contrib. Pl. Ind. 111. 1834.—*S. maritimus* L.

var. *macra* Boeck. In Aitch. Jour. Linn. Soc. 19: 189. 1882.

var. *macrostachyus* Michx. Fl. Bor. Amer. 1: 32. 1803.—*S. robustus* Pursh

var. *macrostachyus* Bertol. in Peterm. Flora 27: 342. 1844.

var. *macrostachya* Pers. Syn. Pl. 1: 68. 1805.—*S. maritimus* L.

var. *macrostachys* Koch, Syn. Fl. Germ. ed. 2, 858. 1844.

var. *minor* Hsm. Fl. v. Tirol 915. 1853.

var. *monostachyus* Sonder, Fl. Hamb. 27. 1851.—*S. maritimus* L.

var. *nobilis* Clarke in Dur. & Schinz, Consp. Fl. Afr. 5: 627. 1895.

var. *paludosus* (Nees) Kük. in Fedde, Repert. 23: 200. 1926.—*S. paludosus* Nels. (*riparius*) Pers. Syn. Pl. 1: 68. 1805.—*S. maritimus* L.

var. *robustus* (Pursh) Kük. in Fedde, Repert. 23: 200. 1926.—*S. robustus* Pursh

var. *salinus* Schur, Enum. Pl. Transs. 693. 1866.

var. *subumbellatus* Schur, Enum. Pl. Transs. 693. 1866.

var. *terrestris* Ridley, Trans. Linn. Soc. Ser. II. 7: 158. 1884.

var. *tuberosus* (Desf.) R. & S. Syst. Veg. 2: 138-140. 1817.—*S. tuberosus* Desf.

var. *umbellatus* Reich. Ic. Fl. Germ. 8: 43. 1846.—*S. maritimus* L.

var. *vulgaris* R. & S. Syst. Veg. 2: 138-140. 1817.

martii Dufour, R. & S. Syst. Veg. 2: 117. 1817.—*Mariscus martii* (Dufour)Fern.

mattfeldianus Kük. in Fedde, Repert. 27: 108. 1929. (Asia # Paucispicata)

mauritanicus Steud. Syn. Pl. Glum. Pars. II. Cyp. 84. 1855.—*S. mucronatus* L.

maximowiczii Clarke, Kew Bull. Add. Ser. 8. 30. 1908.—*Eriophorum maximowiczii* (Clarke) Beetle

maximus Roxb. Hort. Beng. 81. 1814, nomen; Fl. Ind. ed. Carey & Wall, 1: 237. 1820. —*S. grossus* L. f.

medianus Cook, Trans. Roy. Soc. New Zealand 76: 569. 1947. (New Zeal. # Bolboschoenus)

medius Roxb. Fl. Ind. ed. Carey & Wall. 1: 216. 1820.—*Eleocharis fistulosa* (Poir.) Link

medius S. F. Gray, Nat. Arr. Brit. Pl. 2: 75. 1821.—*S. lacustris* L.

megapotamicus Spreng. f. Tent. Suppl. Syst. 4. 1828.—*Rhynchospora luzuliformis* Boeck.

megastachyus Steud. Syn. Pl. Glum. Pars. II. Cyp. 87. 1855.—*S. maritimus* L.

melanocarpus (Torr.) O. Ktze. Rev. Gen. Pl. 1: 757-58. 1891.—*Eleocharis melanocarpa* Torr.

melanocarpus Griseb. Cat. Plant. Cub. 239. 1866.—*Eleocharis pachystyla* (Wright) Clarke

melanocaulos Phil. Anal. Univ. Chile 93: 476. 1896 (# Isolepis)

melanocephalus Griseb. Symb. Fl. Arg. 311. 1879.—*Eleocharis albibracteata* Nees & Meyen

melanocephalus K. Schum. Engl. Pflanzenw. Ost.-Afr. 4: 131. 1895, nomen.

melanorrhizus Boeck. Engl. Bot. Jahrb. 5: 504. 1884.—*S. americanus* var. *longisetis* (Benth & Muell.) Beetle

melanospermus Mey. Mem. Sav. Etr. Petersb. 1: 199. 1831.—*S. supinus* L.

var. *major* Regel, Descr. Pl. Nov. VIII (Acta Hort. Petrop. 7: 558. 1880).—*S. quinquefarius* Buch.-Ham.

var. *typicus* Regel, op. cit. 1880.—*S. supinus* L.

melanospermus Salzm. in Steud. Syn. Pl. Glum. Pars. II. Cyp. 78. 1855.—*Eleocharis flaccida* (Reichenb.) Urban

melanostachys d'Urv. Mem. Soc. Linn. Paris. 4: 600. 1826; (d'Urv. Flor des Molouines 29).—*Eleocharis melanostachys* (d'Urv.) Clarke

melas Kunze in Kunth, Enum. Pl. 2: 169. 1837.—*S. americanus* Pers. var. *polyphyllus* (Boeck.) Beetle

membranaceus Thunb. Prod. Pl. Cap. 17. 1794.—*Ficinia membranacea* Kunth

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meyeri Trautv. Acta Hort. Petrop. 5: 121. 1877 in textu.—*S. pumilus* Vahl

michauxii Pers. Syn. Pl. 1: 68. 1805.—*Fimbristylis autumnalis* (L.) R. & S.

michelianus L. Sp. Pl. 1: 52. 1873.—*Cyperus michelianus* (L.) Link

michelianus Vahl, Enum. Pl. 2: 263. 1806; Siebr. in Kunth, Enum. Pl. 2: 19. 1837.—*Cyperus pygmaeus* Rottb.

michelii Bub. Fl. Pyren. 4: 204. 1901.—*Cyperus pygmaeus* Rottb.

micranthus Vahl, Enum. Pl. 2: 254. 1806.—*Hemicarpha micrantha* (Vahl) Pax

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microlepis Griseb. Cat. Pl. Cubens. 239. 1866.—*Eleocharis nigrescens* (Nees) Steud.
microstachys Boeck. Cyper. Nov. pt. 2, 14. 1890.—*Bulbostylis capillaris* (L.) Clarke
microstachys Phil. Anal. Univ. Chile 93: 478. 1896.—*S. cernuus* Vahl
miliaceus L. Syst. ed. 10. 868. 1759; Thunb. Fl. Jap. 37. 1784.—*Fimbristylis miliacea* (L.) Vahl
miliaceus Roxb. Fl. Ind. ed. Carey 1: 231. 1820.—*Fimbristylis diphylla* (Retz.) Vahl
minaea Tadaro, Rar. Pl. Sic. Decand. 1; in atti acc. Sc. Palermo N. S. 1: 15. 1845.—*S. cernuus* Vahl
mindorensis Beetle, Leafl. West. Bot. 4: 46. 1944.—*Bulbostylis barbata* (Rottb.) Clarke
minimus Roxb. Hort. Beng. 81. 1814, nomen; Fl. Ind. ed. Carey & Wall. 1: 221. 1820.—*Fimbristylis minima* (Roxb.) Hochst
minimus Hook. & Arn. Bot. Beech. Voy. 49. 1841.—*S. cernuus* Vahl
minimus Pursh, Fl. Am. Sept. 1: 55. 1814.—*Hemicarpha micrantha* (Vahl) Pax
minimus Sieber. in Kunth, Enum. Pl. 2: 195. 1837, nomen.—*S. antarcticus* L.
minimus Vahl, Enum. Pl. 2: 253. 1806.—*S. cernuus* & *S. setaceus* mixture acc. picture in Rottb. Desc. Nov. Pl. tab. 15. 1773;—*Bulbostylis barbata* (Rottb.) Clarke acc. to Index Kewensis (cf. Kunth, Enum. Pl. 2: 173. 1837).
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mollis Wall. in Roxb. Fl. Ind. ed. Carey & Wall. 1: 227. 1820.—*Rynchospora*
monander Rottb. Desc. Nov. Pl. 50. 1773.—*Fimbristylis argentea* (Rottb.) Vahl
monander Roxb. Hort. Beng. 81. 1814; Fl. Ind. ed. Carey & Wall. 1: 222. 1820; ed. Wall. 1: 225. 1832.—*Bulbostylis barbata* (Rottb.) Clarke
monander Willd. Sp. Pl. 1: 311. 1809.—*Lipocarpha sphacelata* Kunth
monophyllus Presl, Rel. Haenk. 1: 193. 1828.—*S. americanus* Pers. var. *longisetis* (Benth. & Muell.) Beetle
monostachyos Koen. in Roxb. Hort. Beng. 6. 1814, nomen; Fl. Ind. ed. Carey & Wall. 1: 221. 1820.—*Fimbristylis schoenoides* Vahl
monostachyus (L.) O. Ktze. Rev. Gen. Pl. 3: II. 337. 1898.—*Fimbristylis monostachya* (L.) Hassk.
montanus H.B.K. Nov. Gen. et Sp. 1: 226. 1816; R. & S. Syst. Veg. 2: 153. 1817.—*Eleocharis nodolusa* var. *angulata* Svenson
montevidensis (Kunth) O. Ktze. Rev. Gen. Pl. 1: 758. 1891.—*Eleocharis montevidensis* Kunth
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mucronatus L. Sp. Pl. 1: 50. 1753. (Old World # Actaeogeton)
mucronatus Host. Gram. Austr. 3: 44. 1801-1809.—*S. triqueter* L.
mucronatus Pollich, Hist. Pl. Palat. 1: 44. 1776-1777.—*S. maritimus* L.
mucronatus Pursh, Fl. Am. Sept. 1: 55. 1814.—*S. americanus* L.
mucronatus Roth, Tent. Fl. Germ. 1: 23. 1788.—*S. americanus* var. *triangularis* (Pers.) Beetle
mucronatus Roxb. Fl. Ind. ed. Carey 1: 219. 1832. (Old World # Schoenoplectus)
mucronatus Scop. in Reich. Icon. Fl. Germ. et Helv. 8: 42. 1846.—*S. littoralis* Schrad.
mucronulatus Michx. Fl. Bor. Am. 1: 31. 1803.—*Fimbristylis autumnalis* var. *mucronulata* (Michx.) Fern.
mucronatulatus (Nees) O. Ktze. Rev. Gen. Pl. 1: 758. 1891.—*Eleocharis trichoides* (H.B.K.) Kunth

muehlenbergianus Schult. in R. & S. Syst. Veg. 2: mant. 74. 1824.—*Eleocharis muehlenbergianus* Steud.
muehlenbergii Spreng. Syst. Veg. 1: 207. 1825.—*Bulbostylis barbata* (Rottb.) Clarke
muelleri Boeck. Cyper. Nov. 2: 14. 1890.
multicalamis Bub. Fl. Pyren. 4: 204. 1901.—*Eleocharis multicaulis* Sm.
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multiculmeus Bub. Fl. Pyren. 4: 204. 1901.—*Eleocharis multicaulis* Sm.
muricatus Poir. Encyc. 4: 765. 1804.—*Rynchospora cyperoides* Mart.
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mutatus L. Amoen. Acad. 5: 391. 1759.—*Eleocharis mutata* (L.) R. & S.
mutatus Roxb. in Hook. f. Fl. Brit. Ind. 6: 627. 1894 in syn.—*Eleocharis spiralis* R. Br.
muticus D. Don, Prod. Fl. Nep. 41. 1825.—*S. mucronatus* L.
mysurensis Heyne, in Wall. Cat. n. 3467. 1828.—*S. mucronatus* L.

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var. *anachaetus* Britton, Trans. N. York Acad. Sci. 11: 75. 1892.—*Eleocharis parvula* var. *anachaeta* (Torr.) Svenson
natalensis Boeck. in Clarke in Dur. & Schinz. Consp. Fl. Afr. 5: 623. 1895.—*T. hystrix* Thunb.
natans Boj. Hort. Maurit. 383. 1837.—*S. supinus* L.
natans Griseb. Cat. Pl. Cub. 238. 1866.—*S. confervoides* Poir.
natans Spreng. in Kunth, Enum. Pl. 2: 194. 1837.—*S. rivularis* Schrad.
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nitidulus Link, Jahrb. de Gew. 1: 81. 1820; Willd. in Kunth, Enum. Pl. 2: 232. 1837.—*Fimbristylis laxa* Vahl
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nutans Retz. Obs. 4: 12. 1786.—*Fimbristylis nutans* (Retz.) Vahl
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obtusifolius Heyne in Kunth, Enum. Pl. 2: 239. 1837.—*Fimbristylis junciformis* (Retz.) Kunth
obtusifolius Lam. Illustr. 1: 141. 1791.—*Iria obtusifolia* Hitchc.
obtusus Bigelow, N. Engl. Med. Jour. 5: 335. 1816.—*S. cespitosus* L. var. *callosus* Bigel.
obtusus Willd. in Spreng. Syst. Veg. 1: 204. 1825.—*Eleocharis interstincta* (Vahl) R. & S.
obtusus Willd. Enum. Hort. Berol. 1: 76. 1809.—*Eleocharis obtusa* (Willd.) Schultes
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olneyi Gray, Bost. Jour. Nat. Hist. 5: 238. 1845.—*S. chilensis* Nees & Mey.
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onaei Fr. & Savat. Enum. Pl. Jap. 2: 110. 1879.—*Eleocharis tetraquetra* Nees
orbicephalus Beetle, Madroño 7: 160. 1944. (Mexico # Oxycaryum)
orgyalis Raf. Ann. Nat. 16. 1820.—*S. validus* Vahl or *S. acutus* Muhl.
orientalis Ohwi, Acta Phytotax & Geobot. 1: 76. 1932. (# Taphrogeton)
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ovatus Roth, Tent. Fl. Germ. 2: II. 562. 1793.—*Eleocharis ovata* (Roth) R. & S.

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pallescens Willd. in Link. Hort. Berol. 1: 292. 1827.—*Fimbristylis diphylla* (Retz.) Vahl

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subsp. *eu-paluster* Syme in Becherer in Fedde, Repert. 25: 12. 1908.

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panormitanus Parl. Fl. Ital. 2: 99. 1852.—*S. holoschoenus* L.

paracicularis Wright, Urb. Symb. Ant. 2: 71. 1900; Wright in Kunth, in Fedde, Repert. Beih. 43: 141. 1926.—*Eleocharis microcarpa* Torr.

paradoxus (Spreng.) Boeck. Kjoeb. Vidensk. Meddel. 136. 1869; Linnaea 36: 739. 1870.—*Bulbostylis paradoxa* (Spreng.) Kunth

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var. *nudus* Acta Hort. Petrop. 5: 34. 1930.
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pedicellatus Fern. Rhodora 2: 16. 1900.—.*S cyperinus* var. *laxus* (Gray) Gilly
var. *pullus* Fern. Rhodora 2: 17. 1900.—*S. cyperinus* var. *laxus* (Gray) Gilly
pendulus Muhl. Desc. Gram. 44. 1817.—*S. lineatus* Michx.
pentagonus Roxb. Hort. Beng. 6. 1814, nomen; Fl. Ind. 1: 221. 1820.—*Fimbristylis quinquangularis* Kunth
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petelotii Gross. Notzbl. B. G. Berlin 14: 193. 1938.—(# *Taphrogeton*)
phaeocarpus Phil. f. Cat. Pl. Vasc. Chil. 312. 1881.—*S. antarcticus* L.
philippi Clarke, Engl. Bot. Jahrb. 30, Beibl. 62. 32. 1901.—*S.* inundatus Poir.
philippi Tineo, Pl. Rar. Sicil. 36. 1846.—*S. littoralis* Schrad.
pholioides herb. name in Field Ms. on Buchtien in 1903 from Valdivia, Chile—*S. inundatus* Poir.
pictus Boeck. Linnaea 36: 503. 1870.—*S. cernuus* Vahl
pileatus Fr. & Savat. Enum. Pl. Jap. 2: 110.—1879.—*Eleocharis palustris* (L.) R. & S.
piliferus (Maury) Pickel, Bol. Mus. Nac. Rio de Janiero, 1937, 43: 124. 1938. (Brazil)
pillosus Larrango, Escritos D. A. Larranaga 2: 25. 1823. (Pub. Inst. Hist. Geog. Uruguay).
pilosus Thunb. Prod. Pl. Cap. 18. 1794.—*Fimbristylis pilosa* (Thunb.) Vahl
pilosus Retz. Obs. 6: 19. 1791.—*Fuirena glomerata* Lam.
pinguiculus Clarke in Dur. & Schinz, Consp. Fl. Afr. 5: 629. 1895, nomen. (# Isolepis)
pitardi Trabut in Pitard, Explor. Sc. Maroc. Bot. 112. 1912, nomen; Trabut in Pitard, Contrib. Etude Fl. Maroc. 37. 1918.
planiculmis Schmidt, Reisen Amurl. 190. 1868.—*S. erectus* Poir.
planifolius Grimm, Nov. Act. Nat. Cur. 3: app. 259. 1767.—*Nomochloa compressa* (L.) Beetle
planifolius Muhl. Desc. Gram. 32. 1817.—*S. verecundus* Fernald
var. *brevifolius* Torr. Ann. Lyc. 3: 442. 1836.—*S. clintonii* Gray
plantagineus Swartz, Fl. Ind. Occ. 1: 123. 1797.—*Eleocharis interstincta* (Vahl) R. & S.
plantagineus Retz. Obs. 5: 14. 1789.—*Eleocharis dulcis* (Burm. f.) Trin.
plantagineus Roxb. Hort. Beng. 6. 1814; Roxb. Fl. Ind. ed. Carey & Wall. 1: 212. 1820.—*Fimbristylis quinquangularis* Kunth
plantaginioides Rottb. Desc. Nov. Pl. 45. tab. 15. f. 2. 1773.—*Eleocharis dulcis* (Burm. f.) Trin.
platycarpus Blake, Proc. Roy. Soc. Queensland 51: 180. 1940. (# Isolepis)

plicarhachis Griseb. Cat. Pl. Cub. 239. 1866.—*Eleocharis plicarhachis* (Griseb.) Svenson
plumosus R. Br. Prod. Pl. Nov. Holl. 223. 1810; Regel. Acta Hort. Petrop. 7: 559. 1887.—*S. littoralis* Schrad.
pollicaris Delile, Fl. Aeg. Illustr. 50. t. 63, fig. 10. 1813.—*Eleocharis parvula* (R. & S.) Link
pollichii Gren. & Godr. Fl. France 3: 374. 1855.—*S. triqueter* L.
polycoleus DeNotaris, Ann. Sci. Nat. Ser. 3, 9: 326. 1848.—*S. supinus* L.
polygamus Wright in Boeck. Flora 64: 78. 1881.—*Eleocharis interstincta* (Vahl) R. & S.
polymorphus Dulac. Fl. Hautes-Pyr. 60. 1867.—*S. holoschoenus* L.
polymorphus Salz. in Steud. Syn. Pl. Glum. Pars. II. Cyp. 74. 1855, nomen—*Eleocharis trichoides* (HBK) Kunth
polyopsis Bub. Fl. Pyren. 4: 197. 1901, substitute name for *S. maritimus* L.
polyphyllus Vahl, Enum. Pl. 2: 274. 1806. (N. Am. # Taphrogeton)
f. *macrostachys* (Boeck.) Fern. Rhodora 45: 296. 1943.—*S. peckii* Britton
var. *macrostachys* Boeck. Linnaea 36: 731. 1870.—*S. peckii* Britton
f. *viviparus* (Pursh.) Comb. Nov. *S. exaltatus* Pursh. var. *viviparus* Pursh. Fl. Am. Sept. 56. 1814; Ell. Sk. Fl. S. Car. 1: 88. 1816.
polystachyus Phil. in Clarke, Engl. Bot. Jahrb. 30, Beibl. 68: 36. 1901, nomen.—*S. subasper* var. *polystachyus* (Clarke) Beetle
polystachyus Muell. Trans. Phil. Soc. Vict. 1: 108. 1855. (Old World # Taphrogeton)
polytrichoides Retz. Obs. 4: 11. 1786.—*Fimbristylis polytrichoides* R. Br.
potosiensis Clarke, Kew Bull. Add. Ser. 8: 89. 1908.—*S. analecti* Beetle
potosinus Clarke in Britton, Trans. N. York Acad. Sci. 11: 82. 1892.—*S. analecti* Beetle
praelongatus Poir. Encyc. Meth. 6: 764. 1804.—*S. articulatus* L.
preslii A. Dietr. Sp. Pl. 2: 175. 1833.—*S. mucronatus* L.
pretorianus Boeck. in Clarke in Dur. & Schinz, Consp. Fl. Afr. 5: 613. 1895.—*Bulbostylis cinnamomea* Clarke
pringlei Britton, Bull. Torr. Bot. Club. 15: 103. 1888.—*Bulbostylis pringlei* (Britton) Beetle
productus Clarke, Kew Bull. Add. Ser. 8: 1908. (Tasmania # Eleogiton)
prolifer Rottb. Desc. Nov. Pl. 55. t. 17. 1773. (# Isolepis)
prolifer Thoubg. Fl. Tristan d'Acugn. 36. t. 7. 1811.—*S. thouarsianus* Schult.
prolifer-ramosus Boeck. Flora 58: 261. 1875.—*S. thouarsianus* Schult.
prolifulcus Carse, Trans. & Proc. N. Z. Inst. 60: 752. 1930. hybr.
prolongatus Poir. in Nees, Linnaea 9: 291. 1834.—*S. articulatus* L.
propinquus (R. Br.) Poir. Encyc. Meth. Suppl. 5: 99. 1817.—*Fimbristylis squarrosa* Vahl
psammophilus S. T. Blake, Proc. Roy. Soc. Queens 51: 178. 1940. (# Isolepis)
pseudo-fluitans Makino, Bot. Mag. Tokyo 19: 28. 1905.
pseudoschoenus Steud. Flora 12: 147. 1829.—*Ficinia pseudoschoenus* (Steud.) Fourc.
pseudosetaceus Daveau, Bolet. Soc. Brot. 9: 85. t. I. 1891.
pseudotriqueter Steud. Syn. Pl. Glum. Pars. II. Cyp. 86. 1855.—*S. californicus* var. *tereticulmis* (Steud.) Beetle
pterigosperma (R. Br.) Poir. Encyc. Meth. Suppl. 5: 98. 1817.—*Fimbristylis pterigosperma* R. Br.
pterolepis Kunth, Enum. Pl. 2: 166. 1837. (Afr. # Pterolepis)
puberulus Michx. Fl. Bor. Amer. 1: 31. 1803.—*Fimbristylis spadicea* (L.) Vahl
puberulus Poir. Encyc. Meth. 6: 767. 1804.—*Fimbristylis castanea* var. *puberula* Britton
pubescens Lam. Illustr. 1: 139. 1791.—*Fuirena pubescens* Kunth
pubescens Pers. Syn. Pl. 1: 68. 1805.—*Fimbristylis diphylla* (Retz.) Vahl
pubigerus Bernh. in Link, Hort. Berol. 1: 289. 1827.—*Fimbristylis diphylla* (Retz.) Vahl
pulchellus (Kunth) Boeck. Linnaea 36: 698. 1870.—*Ficinia pulchella* Boeck.
pulcher Rudge, Pl. Guian. 18. t. 23. 1805.—*Hypolytrum pulchrum* (Rudge) Pfeiff.
pulogensis Merrill, Philippi. Jour. Sci. 5: 333. 1910.—*S. clarkii* Stapf
pumilo Spreng. Syst. Veg. 1: 204. 1825.—*Eleocharis pusilla* R. Br.
pumilus Vahl, Enum. Pl. 2: 243. 1806. (northern hemisp. # Baeothryon)
var. *emergens* (Norman) Comb. Nov. (based on *Trichophorum emergens* Norman,

Soc. Reg. Soc. Norweg. 319—Repr. as Spec. Soc. Nat. 79. 1868.)
var. *rollandii* (Fern.) Comb. Nov. (based on *S. rollandii* Fern. Rhodora 45: 282. 1943.)
subsp. *distigmaticus* Kük. A. H. Goth 5: 34. 1929.
pumilus Willd. in Kunth, Enum. Pl. 2: 191. 1837, nomen.—*S. cernuus* Vahl
punctatus (Nees) O. Ktze. Rev. Gen. Pl. 1: 758. 1891.—*Eleocharis punctata* Nees
punctatus (R. Br.) Poir. Encyc. Meth. Suppl. 5: 98. 1817.—*Fimbristylis punctata* R. Br.
punctatus Schrad. in Nees, in Mart. Fl. Bras. 2: I. 93. 1842; Boeck. Linnaea 36: 429. 1870.—*Eleocharis setacea* (Retz.) R. Br.
pungens Vahl, Enum. Pl. 2: 255. 1806.—*S. americanus* Pers. var. *triangularis* (Pers.) Beetle
var. *longisetis* Benth. & Muell. Fl. Austral. 7: 333. 1878.—*S. americanus* var. *longisetis* (Benth. & Muell) Beetle
var. *monstachys* Marsson, Fl. Neuvorp. 516. 1869.—*S. americanus* var. *triangularis* (Pers.) Beetle
var. *nanus* Benth. & Muell. Fl. Austral. 7: 333. 1878.—*S. americanus* var. *longisetis* (Benth. & Muell.) Beetle
var. *polyphyllus* Boeck. Linnaea 36: 709. 1870.—*S. americanus* var. *polyphyllus* (Boeck.) Beetle
pungens Poir. Encyc. Meth. Suppl. 5: 102. 1817.—*Hypolytrum pungens* Vahl
pungens Willd. in Kunth, Enum. Pl. 2: 164. 1837.—*S. lacustris* L.
purpurascens (Boeck.) O. Ktze. Rev. Gen. Pl. 1: 758. 1891.—*Eleocharis congesta* D. Don.
purpureo-ater Linnaea 38: 379. 1874.—*Fimbristylis purpureo-atra* (Boeck.) Clarke
purshianus Fern. Rhodora 44: 479. 1942.—*S. smithii* var. *williamsii* (Fern.) Beetle forma *williamsii* Fern. Rhodora 44: 479. 1942.—*S. smithii* var. *williamsii* (Fern.) Beetle
pusillus Vahl, Enum. Pl. 2: 246. 1806.—*Eleocharis parvula* (R. & S.) Link
pusillus Lucae in Kunth, Enum. Pl. 2: 141. 1837.—*Eleocharis acicularis* (L.) R. & S.
pusillus (R. Br.) Poir. Encyc. Meth. Suppl. 5: 103. 1817.—*Eleocharis pusilla* R. Br.
pusillus Willd. in Kunth, Enum. Pl. 2: 143. 1837; Boeck. Linnaea 36: 436. 1870.—*Eleocharis intermedia* Schult.
pycnostachys Salzm. in Steud. Syn. Pl. Glum. Pars. II. Cyp. 129. 1855.—*Lipocarpha humboldtiana* Nees
pygmaeus Gray, Proc. Am. Acad. 7: 392. 1868.—*S. cernuus* Vahl
pygmaeus Lam. Illustr. 1: 139. 1791.—*Eleocharis chaetaria* R. & S.
pygmaeus Roxb. in Coet. merc. I. O. Must. tab. 752.—*Bulbostylis barbata* (Rottb.) Clarke

quadrangularis Thou. Cat. Hort. Maurit. 4. 1822.—*Fimbristylis miliacea* (L.) Vahl.
quadrangulatus Michx. Fl. Bor. Amer. I. 30. 1803.—*Eleocharis quadrangulata* (Michx.) R. & S.
quadrangulatus Muhl. Cat. 6. 1813, nomen.—*Eleocharis tenuis* (Willd.) Schult.
quadrangulus D. Don, Prod. Pl. Nep. 40. 1825.
quadriflorus Boeck. Linnaea 36: 761. 1870.—*Fimbristylis quadriflorus* (Boeck.) comb. nov.
quadrisetis Ehrenb. in Boeck. Linnaea 36: 466-67. 1870.—*Eleochardis palustris* (L.) R. & S.
quinquangularis Vahl, Enum. Pl. 2: 279. 1806.—*Fimbristylis quinquangularis* Kunth
quinquefarius Buch.-Ham. in Wallich. Cat. n. 3465. 1828, nomen; Boeck. Linnaea 36: 701. 1870.—*S. roylei* (Nees in Wight) Beetle
quinqueflorus Vitm. Summa Pl. 1: 150. 1789.—*Eleocharis pauciflora* (Lightf.) Link

racemosus Spreng. Syst. Veg. 1: 213. 1825.
radiatus Steud. Nom. ed. 2: 541. 1841.—*Eleocharis radicans* (Poir.) Kunth
radiatus Thunb. Prod. Pl. Cap. 18. 1794.—*Ficinia radiata* (L. f.) Kunth
radicans Poir. Encyc. Meth. 6: 651. 1804.—*Eleocharis radicans* (Poir.) Kunth
radicans Schkuhr. Uster. d. Bot. 5: 49. tab. I. 1793.—(Old World # Taphrogeton)

radiciflorus Maury. Jour. de Bot. 3: 169. fig. 9. 1889.—*Bulbostylis radiciflorus* (Maury.) comb. nov.
ramosus Boeck. Linnaea 38: 377. 1874.—*S. fluitans* L.
ranco (Steud.) comb. nov. *Cyperus ranco* Steud. Syn. Pl. Glum. Pars. II. Cyp. 315. 1855.—replaces *S. perpusillus* Boeck. (# Isolepis)
rarus (R. Br.) Poir. Encyc. Meth. Suppl. 5: 99. 1817.—*Fimbristylis rara* R. Br.
reclinatus Beyr. in Kunth, Enum. Pl. 2: 143. 1837.—*Eleocharis intermedia* (Muhl.) R. & S.
reductus Cherm. Bull. Soc. Bot. France 68: 423. 1922. (Africa # Actaeogeton)
rehmanni Ridl.. Trans. Linn. Soc. Ser. II. 2. 159. 1884.—*S. hystrix* Thunb.
rehmannianus Boeck. in Clarke; Dur. & Schinz, Consp. Fl. Afr. 5: 629. 1894, nomen. *S. roylei* (Nees in Wight) Beetle
reichei Boeck. Engl. Bot. Jahrb. 21: 43. 1895, nomen; Allg. Bot. Zeit. 2: 55. 1896; Phil. Anal. Univ. Chile 93: 480. 1896.—*S. americanus* Pers. var. *longisetis* (Benth. & Muell.) Beetle
reichenbachii Boeck. Linnaea 36: 737. 1870.—*Bulbostylis conifera* (Kunth) Beetle
remireoides Griseb. Goett. Abh. 19: 266. 1874; Griseb. Pl. Lorent. 218. 1874.—*S. nevadensis* S. Wats. var. *remireoides* (Griseb.) Beetle
renschii Boeck. Engl. Bot. Jahrb. 5: 504. 1884.—*Bulbostylis renschii* (Boeck.) Clarke
repens Petit-Thouars in Link, Jahrb. de Gew. 1: 81. 1820, nomen.
repens Willd. in Schult. in R. & S. Syst. Veg. 2: mant. 84. 1824.—*Eleocharis intricata* Kük.
reptans Rich. Act. Soc. Hist. Nat. Par. 1: 106. 1792.—*Dichromena repens* Vahl
repans Thuill. Fl. Par. ed. 2. 22. 1824.—*Eleocharis palustris* (L.) R. & S.
reticulatus Lam. Illustr.1: 142. 1791, nomen dubium (perhaps *S. atrovirens* Willd.)
retroflexus Griseb. Cat. Pl. Cub. 239. 1866.—*Eleocharis oligantha* Clarke
retroflexus Poir. Encyc. Meth. 6: 753. 1804.—*Eleocharis retroflexa* (Poir.) Urban
retrofractus L. Sp. Pl. 1: 50. 1753.—*Cyperus retrofractus* (L.) Torr.
retusus Koen. in Wall. Cat. n. 3428. 1828.—*Rhynchospora wallichiana* Kunth
rigescens Petit-Thouars in Link, Jahrb. de Gew. 1: 81. 1820, nomen.
rigescens Willd. in Schult. in R. & S. Syst. Veg. 2: mant. 84. 1824.—*Fimbristylis spathacea* Roth
rigidus Boeck. Linnaea 36: 492. 1870. (S. Am. # Baeothryon)
rigidus Griseb. Goett. Abh. 24: 312. 1879; Griseb. Symb. Fl. Arg. 312. 1879.—*Fimbristylis rigidus* (Griseb.) comb. nov.
rigidus Schrad. in Nees in Mart. Fl. Bras. 2: I. 107. 1842, nomen.—*S. californicus* (Mey.) Steud.
riparius Presl, Rel. Haenk. 1: 193. 1828.—*S. tatora* Kunth
var. *chamissoi* Pfeiff. Rep. Spec. Nov. 33: 203. 1933.—*S. californicus* (Mey.) Steud. var. *chamissoi* (Nees) Beetle
var. *paschalis* Kük. in Fedde, Repert. 16: 432. 1920.—*S. californicus* (Mey.) Steud. var. *paschalis* (Kük.) Beetle
var. *tereticulmis* (Steud.) Clarke, Engl. Bot. Jahrb. 30. Beibl. 68: 36. 1901.—*S. californicus* var. *tereticulmis* (Steud.) Beetle
riparius Poir. Encyc. Meth. Suppl. 5: 103. 1817; Spreng. Syst. Veg. 1: 208. 1825.—*S. cernuus* Vahl
riparius Pers. Syn. Pl. 1: 68. 1805.—*S. maritimus* L.
rivularis (Schrad.) Parl. Fl. Ital. 2: 83. 1852; Boeck. Linnaea 36: 504. 1870.—(# Isolepis)
rivularis Don in Nees, Linnaea 9: 288. 1834.—*Fuirena rivularis* Nees
robustus Pursh, Fl. Am. Sept. 1: 56. 1816. (N. Amer. # Bolboscoenus)
var. *campestris* (Britton) Fern. Rhodora 2: 241. 1900.—*S. paludosus* Nels.
var. *compactus* Davy in Jepson, Fl. W. Middl. Calif. 88. 1901.—*S. paludosus* Nels.
var. *novae-angliae* (Britton) Beetle, Am. Jour. Bot. 29: 87. 1942. (N. Am.)
var. *paludosus* (Nels.) Fern. Rhodora 2: 241. 1900.—*S. paludosus* Nels.
f. *protrusus* Fern. Rhodora 45: 392. 1943.—*S. robustus* Pursh.
rockii Kük. in Fedde, Repert. 16: 432. 1920.—*S. erectus* Poir.
rogersii N. E. Brown, Kew. Bull. 301. 1921. (Afr. # Actaeogeton)

rollandii Fern. Rhodora 45: 282. 1943.—*S. pumilus* Vahl var. *rollandii* (Fern.) Beetle
romanus L. Sp. Pl. 1: 49. 1753.—*S. holoschoenus* L.
rosellinii Ces. Pass. & Gibelli, Compend. Fl. Ital. 99. 1867.—*S. lacustris* L.
rostellatus Torr. Ann. Lyc. N. Y. 3: 318. 1836.—*Eleocharis rostellata* Torr.
rosthornii Diels, Engl. Bot. Jahrb. 29: 228. 1900. (# Taphrogeton)
rothii Hoppe in Sturm, Deutschl. Fl. Heft. 9: 36. 1814.—*S. americanus* Pers. var. *triangularis* (Pers.) Beetle
var. *monostachys* Sonder. Fl. Hamb. 27. 1851.—*S. americanus* Pers. var. *triangularis* (Pers.) Beetle
roylei (Nees in Wight) Beetle, Am. Jour. Bot. 29: 655. 1942. (India # Actaeogeton)
rubicundus (Nees) Parl. Fl. Ital. 2: 83. 1852. (see under *S. capillifolius*) Two later combinations, both in 1944, (Nees) Levyns and (Nees) Beetle are unnecessary. (Afr. # Eleogiton)
rubiginosus Beetle, Am. Jour. Bot. 28: 697. 1941. (N. Am. # Pterolepis)
rubricosus Fern. Rhodora 47: 124. 1945.—*S. cyperinus* (L.) Kunth var. *eriophorum* (Michx.) Kunth
rubrotinctus Fern. Rhodora 2: 20. 1900. (N. Am. # Tophrogeton)
var. *confertus* Fern. Rhodora 2: 21. 1900.
f. *confertus* (Fern.) Weatherby, Bull. Conn. State Geol. & Nat. Hist. Soc. 48: 29. 1931.
f. *radiosus* Fernald, Rhodora 45: 295. 1943.
rufescens Boeck. Kjoeb. Vidensk. Meddel. 138. 1869; Linnaea 36: 755. 1870.—*Bulbostylis rufescens* (Boeck.) comb. nov.
rufus Schrad. Fl. Germ. 1: 133. t. 1. f. 3. 1806.—*Nomochloa rufa* (Schrad.) Beetle
var. *neogaeus* Fern. Rhodora 45: 287. 1943.—*Nomochloa rufa* (Schrad.) Beetle var. *neogaea* (Fern.) Beetle
ruppioides Thw. in Sauv. Fl. Cub. 176, in obs. 1871.—*S. confervoides* Poir.

sachalinensis Meinsh. Acta Hort. Petrop. 18: 260. 1900.—*Eleocharis sachalinensis* (Meinsh.) Komarov
salbundius Buch.-Ham. in Wallich Cat. n. 3499. 1828.—*Fimbristylis quinquangularis* Kunth
salinus Schmidt in Steud. Nom. ed. II. 2. 541. 1841.—*S. robustus* Pursh
sasakii Hayata, Ic. Pl. Formos. 6: 115. 1916, nomen.
savii Sebast. & Mauri, Fl. Rom. Prod. 22. 1818.—*S. cernuus* Vahl
saximontanus Fern. Rhodora 3: 251. 1901.—*S. supinus* var. *hallii* Gray
scaber (Presl) O. Ktze. Rev. Gen. Pl. 3: II. 337. 1898.—*Bulbostylis capillaris* (L.) Clarke
scaber Roxb. Hort. Beng. 81. 1814, nomen; Roxb. Fl. Ind. ed. Carey & Wall. 1: 234. 1820.—*Fimbristylis acuminata* Vahl
scaberrimus Boeck. Flora 41: 595. 1858.—*S. grossus* L. f.
scabriculmis Beetle, Am. Jour. Bot. 33: 665. 1946. (Asia # Paucispicata)
scariosus R. & S. Syst. Veg. 2: 61. 1817; Syst. Veg. 2: mant. 40. 1824.—*Ficinia bracteata* Boeck.
schaffneri Boeck. Flora 61: 30. 1878; Boeck. Engl. Bot. Jahrb. 7: 257. 1886. (Mexico # Oxycaryum)
schaffneri (Boeck.) O. Ktze. Rev. Gen. Pl. 1: 758. 1891.—*Eleocharis schaffneri* Boeck.
scheuchzeri Vitm. Summa Pl. 1: 150. 1789.—*Eriophorum vaginatum* L.
schimperianus Boeck. Linnaea 36: 750. 1870.—*Bulbostylis schimperianus* (A. Rich.) Clarke
schinzianus Boeck. in Clarke, in Dur. & Schinz, Consp. Fl. Afr. 5: 618. 1895.—*S. burkei* Clarke
schinzii Boeck. Verh. Bot. Ver. Brand. 29: 47. 1888.—*S. dioecus* Boeck.
schmidtianus Junge, Jahrb. Hamb. Wiss. Aust. 22; Beiheft. 72. 1903. hybr.
schoenodes Boeck. in O. Ktze. Rev. Gen. Pl. 3: 2, 337. 1898.—*S. schoenoides* Boeck.
schoenoides Boeck. Linnaea 36: 750. 1870.—*Ficinia*
schoenoides Ell. Sk. Fl. S. Car. 1: 89. 1816.—*Rhynchospora schoenoides* (Ell.) Britton
schoenoides Retz. Obs. 5: 14. 1789.—*Fimbristylis schoenoides* (Retz.) Vahl

schoenoides Roxb. Hort. Beng. 6. 1814; Fl. Ind. ed. Carey & Wall. 1: 221. 1820.—*Fimbristylis monostachya* Hassk.
schomburgkianus Boeck. Linnaea 36: 757. 1870.—*Rhynchospora*
schoofii Beetle, Am. Jour. Bot. 29: 654. 1942.—(China # Actaeogeton)
schotensis Meinsch. Acta Hort. Petrop. 18: 248. 1900.
schweinfurthianus Boeck. Linnaea 36: 758. 1870.—*Bulbostylis abortiva* Clarke
scleropus (Clarke) K. Schum. in Just. Jahresb. 26: 239. 1898.—*Bulbostylis scleropus* Clarke
schwackeanus Boeck. Cyper. Nov. 2: 15. 1898.—*Bulbostylis sphaerocephala* f. *schwackeana* Lindm.
sellowianus Boeck. Kjoeb. Vidensk. Meddel. 138. 1869; Boeck. Linnaea 36: 748. 1870.—*Fimbristylis sellowianus* (Boeck.) comb. nov.
sellowianus (Kunth) Griseb. Goett. Abh. 24: 312. 1879; Griseb. Sym. Fl. Argent. 312. 1879.—*Eleocharis sellowiana* Kunth
sellowianus (Kunth) O. Ktze. Rev. Gen. Pl. 1: 758. 1891.—*Eleocharis sellowiana* Kunth
semisubterraneus Boeck. Linnaea 36: 495. 1870. (A. Am. # Monocephales)
semiuncialis Clarke, Kew Bull. Add. Ser. 8: 29. 1870. (# Isolepis)
senegalensis Lam. Illustr. 1: 140. 1791.—*Lipocarpha senegalensis* (Lam.) Th. & H. Durand
seonanei Merino, Contrib. Fl. Galic. 173. 1897.
sepium Honck. Verz. All. Gew. Teutsch. 1: 78. 1782.—*Eleocharis pauciflora* (Lightf.) Link
sepulcralis Steud. Syn. Pl. Glum. Pars. II. Cyp. 94. 1858.—*S. cernuus* Vahl
sericeus Poir. Encyc. Meth. Suppl. 5: 99. 1817.—*Fimbristylis sericea* R. Br.
serrulatus Vahl, Eclog. Am. 3: 1. 1896-1898.—*Fimbristylis diphylla* (Retz.) Vahl
sesquipollicaris Willd. in Kunth, Enum. Pl. 2: 203. 1837, nomen.—*Hemicarpha micrantha* (Vahl) Pax
sessiliflorus Phil. Anal. Univ. Chile 93: 479. 1896. (# Isolepis)
setaceus L. Sp. Pl. 1: 73. 1753. (cosmop. # Isolepis)
var. *clathratus* Reichenb. in Bonnier, Fl. Compl. France, Suisse, & Belg. 11: 79. 1931.
var. *gracillimus* Rouy in Bonnier, Fl. Compl. France, Suisse, & Belg. 11: 80. 1931.
var. *monandra* Link, Jahrb. de Gew. 1: 78. 1820. (Willd. hb. n. 1198). = *S. isolepis* (Nees) Boeck.
var. vel forma *pedicellata* Druce, Rep. Bot. Exch. Cl. Brit. Isles 7: 68. 1924.
var. *pygmaeus* J. Ball. Jour. Linn. Soc. 22: 167. 1886.—*S. setaceus* L.
var. *trachyspermus* (Nees) Boeck. Linnaea 36: 50. 1870.—*S. cernuus* Vahl
setaceus L. mant. 2: 321. 1771.—*S. cernuus* Vahl
var. *trigonocarpus* f. *pusillus* Boeck. Linnaea 36: 502. 1870; Phil. Cat. Fl. Chile 309. 1881.—*S. cernuus* Vahl
setaceus Sieber in Steud. Syn. Pl. Glum. Pars II. Cyp. 92. 1855.—*S. cernuus* Vahl
setaceus Thunb. Prod. Pl. Cap. 17. 1794.—*S. antarcticus* L.
setifolius Boeck. Flora 62: 160. 1879.—*Bulbostylis setifolius* (Boeck.) comb. nov.
setiformis Schrad. in Boeck. Linnaea 36: 451. 1870, nomen in synon. *Eleocharis pachycarpa* Desv.
setiformis (Benth.) Blake, Proc. Roy. Soc. Queens 51: 178. 1940. (# Isolepis)
siculus Lojac. Fl. Sic. 3: 214. 1909.
silvaticus of many authors equals *sylvaticus*
sieberi (Kunth) O. Ktze. Rev. Gen. Pl. 1: 758. 1891.—*Eleocharis variegata* Presl
simplex Ell. Sk. Fl. S. Car. 1: 76. 1816.—*Eleocharis tuberculosa* (Michx.) R. & S.
sinensis Osb. in Kunth, Enum. Pl. 2: 202. 1837, nomen—*Fimbristylis squarrosa* (L.) Vahl
smithii Gray, Man. Bot. N. U. S. ed. 5: 563. 1867. (N. Am. # Actaeogeton)
var. *levisetus* Fassett, Rhodora 23: 42. 1921.—*S. smithii* Gray
var. *setosus* Fern. Rhodora 3: 252. 1901.—*S. smithii* var. *williamsii* (Fern.) Beetle
f. *levisetus* (Fern.) Fern. Rhodora 44: 479. 1942.—*S. smithii* Gray
f. *setosus* (Fassett) Fern. Rhodora 44: 479. 1942.—*S. smithii* var. *williamsii* (Fern.) Beetle

var. *williamsii* (Fern.) Beetle, Amer. Jour. Bot. 29: 655. 1942. (N. Am.)
solispicatus Lunnell, Amer. Midl. Nat. 4: 230. 1915.—*S. americanus* Pers.
soloniensis Dubois, Meth. Orl. 295. 1803; Dubois, Meth. ed. II. 249.—*Eleocharis ovata* (Roth) R. &. S.
sororius (Kunth) Clarke in Dur. & Schinz. Consp. Fl. Afr. 5: 630. 1895.—*S. cernuus* Vahl
spadiceus (Lam.) Boeck. Linnaea 36: 493. 1870. = *Schoenus spadiceus* Vahl
spadiceus L. Sp. Pl. 1: 51. 1753.—*Fimbristylis spadicea* (L.) Vahl
var. *ciliatus* Ridl. Trans. Linn. Soc. Ser. II. 7: 156. 1884.
spadiceus Phil. Linnaea 29: 80. 1857-58.—*Schoenus* nitens Poir.
sparmanni Lam. Illustr. 1: 140. 1891.—*Ficinia sylvatica* Kunth
spathaceus Hochst. in Krauss, Flora 28: 759. 1845.—*S. inanis* (Thunb.) Steud.
spathaceus Michx. Fl. Bor. Am. 1: 32. 1803.—*Dulichium arundinaceum* (L.) Britton
speciosus Salisb. Prod. 31. 1796.—*Eriophorum polystachion* L.
sphaceolatus (R. Br.) Poir. Encyc. Meth. Suppl. 5: 102. 1817.—*Eleocharis sphacelata* R. Br. (R. Br.) Link; (R. Br.) Spreng.; and (R. Br.) O. Ktze. are all the same combination made at later dates.
sphaerocarpus Boeck. Linnaea 36: 741. 1870.—*Bulbostylis sphaerocarpa* (Boeck.) Clarke
sphaerocephalus Boeck. Kjoeb. Vidensk. Meddel. 137. 1869; Boeck. Linnaea 36: 748. 1870.—*Bulbostylis sphaerocephala* (Boeck.) Clarke
sphaerolepis Boeck. Kjoeb. Vidensk. Meddel. 140. 1869; Boeck. Linnaea 36: 766. 1870. —*Bulbostylis sphaerolepis* (Boeck.) comb. nov.
spiralis Bosc. in Kunth, Enum. Pl. 2: 145. 1837.—*Eleocharis tortilis* (Link) Schult.
spiralis Rottb. (Desc. Nov. Pl. 42) Desc. et Ic. 45. t. 15. fig. 1. 1773.—*Eleocharis spiralis* (Rottb.) R. & S.
spiralis Willd. in Kunth, Enum. Pl. 2: 153. 1837.—*Eleocharis dulcis* (Burm. f.) Trin.
spiralis Druce, Rep. Bot. Exch. Cl. Brit. Isles 1: 646. 1917.—*Desmoschoenus frondosus* Hook. f.
spiraloides Roxb. Hort. Beng. 81. 1814, nomen.—*Eleocharis fistulosa* (Poir.) Link
squamosus Vahl, Enum. Pl. 2: 259. 1805; Link, Jahrb. de Gew. 1: 79. 1820.—*Hemicarpha micrantha* (Vahl) Pax
squarrosulus Steud. Syn. Pl. Glum. Pars. II, Cyp. 88. 1855.—*S. maritimus* L.
var. *dietrichiae* Bailey, Synop. Queensl. Fl. 601. 1883; Benth: & Muell. Fl. Austral. 7: 329. 1878.
squarrosus (Vahl) O. Ktze. Rev. Gen. Pl. 3: II. 337. 1898.—*Fimbristylis squarrosa* Vahl
squarrosus L. Mant. 1: 181. 1767.—*S. chinensis* Osbeck
var. *multiflorus* O. Ktze. Rev. Gen. Pl. 1: 757. 1891.
var. *normalis* O. Ktze. Rev. Gen. Pl. 1: 757. 1891.
var. *siamensis* Clarke in LeCompte, Flore General de L'Indo-Chine 7: 134. 1912.
squarrosus (Vahl) Poir. Ency. Meth. Suppl. 5: 100. 1817.—*Fimbristylis squarrosa* Vahl
squarrosus Spreng. Syst. Veg. 4; cur. Post. 28. 1827.—*S. thouarsianus* Schult.
stans Desv. in Ham. Prod. Pl. Ind. Occ. 14. 1825. = *Fimbristylis*
stauntoni Clarke, Jour. Linn. Soc. 36: 253. 1903. = *Cyperus*
steinmetzii Fern.. Rhodora 45: 286. 1943.—*S. validus* var. *condensatus* (Peck) Beetle f. *creber* (Fern.) Beetle
stellatus Clarke, Kew Bull. Add. Ser. 8: 29. 1908. (# Isolepis)
stenophyllus Ell. Sketch. Fl. S. Car. 1: 83. 1816.—*Bulbostylis stenophyllis* (Ell.) Fern.
sterilis Salzm. in Steud. Syn. Glum. Pars. II. Cyp. 118. 1855.—*Fimbristylis spadicea* (L.) Vahl
sterilis Maiden & Betche, Proc. Linn. Soc. New S. Wales 33: 315. 1908.—*Bulbostylis barbata* (Rottb.) Clarke
steudneri Boeck. Linnaea 36: 733. 1870. (# Isolepis)
stolonifer (Nees) O. Ktze. Rev. Gen. Pl. 1: 758. 1891.—*Eleocharis stolonifer* Nees
stolonifer Roth, Usteri, Ann. Bot. 10: 36. 1794.—*S. fluitans* L.
stramineus Presl, Oken Isis 21: 269. 1828.
striatulus Griseb. Goett. Abh. 19: 266. 1874.—*Eleocharis bonariensis* Nees
striatus (Nees) Fourcade, Trans. Roy. Soc. Afr. 21: 76. 1934. (Afr. # Eleogiton)

strictus Poir. Encyc. Meth. Suppl. 5: 99. 1817.—*Fimbristylis diphylla* (Retz.) Vahl
strictus Roxb. Hort. Beng. 81. 1814, nomen; Fl. Ind. ed. Carey & Wall. 1: 226. 1820. —*Fimbristylis spathacea* (L.) Vahl
strobiliferus Steud. Syn. Pl. Glum. Pars II. Cyp. 317. 1855.—*S. robustus* Pursh
strobilinus Roxb. Hort. Beng. 6. 1814, nomen; Fl. Ind. ed. Carey & Wall. 1: 222. 1820. (Turkestan & India # Bolboschoenus)
stygius Ferber in Fleischer, Syst. Verz. Ostsee-Prov. Bek. Gew. Phan. 120. 1830.—*Juncus stygius* L.
subaphyllus Boeck. Linnaea 36: 705. 1870, nomen.—*S. subcapitatus* Thw.
subappendiculatus Steud. Syn. Pl. Glum. Pars. II. Cyp. 84. 1855.—*S. americanus* Pers. var. *triangularis* (Pers.) Beetle
subarticulatus Roxb. Hort. Beng. 81. 1814, nomen; Fl. Ind. ed. Carey & Wall. 1: 217. 1820.—*S. articulatus* L.
subarticulatus (Nees) O. Ktze. Rev. Gen. Pl. 1: 758. 1891.—*Eleocharis subarticulata* Nees
subasper Beetle, in Macbride; Univ. of Cuzco, Rev. Universitaria 1945. (S. Am. # Androcoma)
var. *polystachya* (Clarke) Beetle in Macbride; Univ. of Cuzco, Rev. Universitaria. 1945.
var. *diffusus* Beetle, Am. Jour. Bot. 33: 661. 1945.
subcapitatus Thw. Enum. Pl. Zeyl. 351. 1864. (Asia # Paucispicata)
subcululatus Berggren, N. Y. Zeyl. Fanerog. 12. t. 5. f. 16-20.—*S. aucklandicus* Boeck.
subdistichus Boeck. Linnaea 36: 490. 1870.—*Bulbostylis subdisticha* (Boeck.) Beetle
submersus Wight in Sauv. Fl. de Cuba 175. 1871; Wight in Sauv. Anal. Acad. Cienc. Habana 8: 79. 1871.—*S. confervoides* Poir.
submuticus (Roxb. in Coet. Merc. I. O. Mus. tab. 738. fide Arn.) Roxb. in Wight, Contrib. Pl. Ind. 114. 1834.—*Eleocharis media* Nees
subprolifer Boeck. Linnaea 36: 492. 1870.—*S. cernuus* Vahl
subquadrangularis Makino, Jour. Jap. Bot. 7: 8. 1931.
subquadriflorus Boeck. Kjoeb. Vidensk. Meddel. 139. 1869.—*Fimbristylis quadriflorus* (Boeck.) Beetle
subsquarrosus Muhl. Desc. Gram. 39. 1817.—*Hemicarpha micrantha* (Vahl) Pax var. *humboldtii* (Boeck.) Beetle
subterminalis Torr. Fl. No. & Midl. U. S. 1: 47. 1824. (N. Am. # Schoenoplectus)
var. *terrestris* Paine, Cat. Pl. Oneida Co. 96. 1865.—*S. subterminalis* Torr.
f. *terrestris* (Paine) Fern. Rhodora 45: 288. 1943.—*S. subterminalis* Torr.
subtilis Boeck. Allg. Bot. Zeit. 2: 54. 1896; Boeck. in O. Ktze. Rev. Gen. Pl. 1: 758. 1891.—*S. cernuus* var. *californicus* (Torr.) Beetle
subulatus Vahl, Enum. Pl. 2: 268. 1906. (Asia # Pterolepis)
var. *capensis* Boeck. Linnaea 36: 717. 1790.—*S. pterolepis* Kunth
subviviparus (Boeck.) O. Ktze. Rev. Gen. Pl. 1: 758. 1891.—*Eleocharis subvivipara* Boeck.
sulcatus Thouars. Fl. Tristan d'Acugn. 36. t. 7. 1811.—(# Isolepis)
var. *distigmatosa* Clarke, in Cheesman, Man. N. Zeal. Fl. 775-776. 1906.
var. *moseleyanus* Hemsl. Voy. Challenger Bot. 2: 155. 1854.—*S. moseleyanus* (Hemsl.) Boeck.
sulcatus Ell. Sk. Fl. S. Car. 1: 56. 1816.—*Fimbristylis diphylla* (Retz.) Vahl
sulcatus Roth, Nov. Pl. Sp. 30. 1821.—*Eleocharis filiculmis* Kunth
sulciculmis Schrad. in Nees, in Mart. Fl. Bras. ed. 2; I. 103. 1842.—*Eleocharis atropurpurea* (Retz.) Kunth
sundanus Miq. Fl. Ind. Bot. 3: 304. 1855.—*S. mucronatus* L.
supinus L. Sp. 1: 49. 1753. (Europe # Actaeogeton)
var. *digynus* Boiss. Fl. Orient. 5: 380-381. 1884.
var. *elatior* Boeck. Linnaea 36: 699. 1870.
var. *minimus* Boiss. Fl. Orient. 5: 380-381. 1884.
var. *hallii* Gray, Man. Bot. N. U. S. ed. 5, 563. 1867. (N. Am.)
var. *uninodis* Clarke in Hook. f. Fl. Brit. Ind. 6: 656. 1894. (Old World)

swampianus Bosc. in Kunth, Enum. Pl. 2: 168. 1837.—*S. maritimus* L.
sylvaticus L. Sp. Pl. 1: 49. 1753. (Old World # Taphrogeton)
var. *atrovirens* (Willd.) Gray, Man. rev. ed. 500. 1859.—*S. atrovirens* Willd.
f. *bissellii* (Fern.) Carpenter in Dole, Fl. Vermont 3rd. 3: 76. 1937.—*S. sylvaticus* var. *bissellii* Fern.
var. *bissellii* Fern. Rhodora 2: 21. 1900. (N. Am.)
f. *cephaloideus* Sheldon, Bull. Geol. & Nat. Hist. Surv. Miss. 9: 68. 1894.—*S. cyperinus* f. *cephaloideus* (Sheldon) Beetle
var. *compactus* Klinggr. in Bonnier, Fl. Compl. France, Suisse & Belg. 11: 75. 1931.
var. *digynus* Boeck. Linnaea 36: 727. 1870; Gray, Man. ed. 6. 581. 1889. = *S. microcarpus* Presl
var. *dissitiflorus* Sonder, Fl. Hamb. 27. 1851.
var. *maximowiczii* Regel. Flor. Ussur. 161. 1861.—*S. orientalis* Ohwi
var. *microcarpus* (Presl) MacMill. Metasp. Minn. Valley 97. 1892. = *S. microcarpus* Presl
var. *pedicellatus* Peterm. in Bonnier, Fl. Compl. France, Suisse & Belg. 11: 75. 1931.
var. *radicans* (Schr.) Vahl, Enum. Pl. 2: 272. 1806.—*S. radicans* Schr.
var. *synchnocephalus* S. N. Cowles, Am. Nat. 3: 101. 1869.—*S. atrovirens* Willd. f. *synchnocephalus* (Cowles) Blake

tabernaemontani Gmel. Fl. Bad. 1: 101. 1805.—*S. lacustris* var. *tabernaemontani* (Gmel.) Döll.
var. *capitatus* Hansskn. Bot. Geo. Thur. 6: 31. 1888.—*S. lacustris* var. *tabernaemonti* (Gmel.) Doell.
var. *minimus* Schur. Enum. Pl. Transs. 694. 1866.
var. *paludosus* R. & S. Syst. Veg. 3: 537. 1827.—*S. lacustris* var. *tabernaemontani* (Gmel.) Döll.
var. *salinus* R. & S. Syst. Veg. 3: 537. 1827.—*S. lacustris* var. *tabernaemontani* (Gmel.) Döll.
tabernaemontani Salz. in Ball, Jour. Linn. Soc. 16: 702. 1878.—*S. littoralis* Schrad.
tabernaemontani X *triqueter* see *S. arunensis*
tatora Kunth, Enum. Pl. 2: 166. 1837. (S. Am. # Pterolepis)
tegetalis Burch. Trav. 1: 260. 1822, in nota—*S. inanis* (Thunb.) Steud.
tenellus Link, Jahrb. de Gew. 1: 80. 1820.—*Bulbostylis tenellus* (Link) Clarke
tenellus Roxb. Hort. Beng. 81. 1814, nomen; Roxb. ed. Carey & Wall. Fl. Ind. 1: 227. 1820.—*Fimbristylis tenellus* Schult.
tener Spreng. Syst. Veg. 1: 204. 1825.—*Eleocharis acuta* R. Br.
tenerrimus Schrad. in Nees in Mart. Fl. Bras. ed. 2: I. 94. 1842.—*Eleocharis minima* Kunth
tenerrimus Peter, Fedde, Repert. Beih. 40: I. Anhang, 124. 1936.
tenuiculmis Schrad. in Schult. Mant. II. 74. 1824.—*Eleocharis rothiana* Boeck.
tenuiculus—tenuiculmis
teunifolius Lam. in DC. Fl. Suppl. 5: 300. 1815.—*S. americanus* Pers. var. *triangularis* (Pers.) Beetle
tenuifolius Rudge, Pl. Guin. 18. t. 22. 1805.—*Bulbostylis capillaris* (L.) Kunth or *B. tenuifolius* (Rudge) Nees
tenuis Spreng. Flora 12: Beil. pg. 12. 1829.—*S. africanus* Beetle
tenuis Spreng. in Boeck. Linnaea 36: 478. 1870.—*S. nanodes* Levyns
tenuis Schreb. in Schweigg. & Koerte, Fl. Erland. 12. 1811.—*Eleocharis palustris* (L.) R. & S.
tenuis Willd. Enum. Hort. Berol. 1: 76. 1809.—*Eleocharis capitata* (L.) R. Br.
tenuispicatus Boeck. Linnaea 36: 740. 1870.—*Bulbostylis tenuispicata* (Boeck.) Barros
tenuissimus (Boeck.) O. Ktze. Rev. Gen. Pl. 1: 758. 1891.—*Eleocharis tenuissimus* Boeck.
tenuissimus (Nees) Boeck. Linnaea 36: 481. 1870. (# Isolepis)
var. *capillaris* Boeck. Linnaea 36: 481. 1870.—*S. cernuus* Vahl
var. *fluitans* Boeck. Linnaea 36: 481. 1870.—*S. tenuissimus* (Nees) Boeck.

tereticulmis Steud. Syn. Pl. Glum. Pars. II. Cyp. 85. 1855.—*S. californicus* var. *tereticulmis* (Steud.) Beetle
terminalis Phil. Anal. Univ. Chil. 93: 479. 1896.—*S. cernuus* Vahl
ternatanus Reinw. in Miq. Fl. Ind. Bot. 3: 307. 1855. (Asia # Hymenochaeta)
var. *sutchuensis* Tang. Bull. Fan. Mem. Inst. Biol. 3: 361. 1932.
ternatensis of authors—*S. ternatanus* Reinw. in Miq.
ternatus Ham. in Hook. f. Fl. Brit. Ind. 6: 656. 1894, in syn.
tetragonus (R. Br.) Poir. Encyc. Meth. Suppl. 5: 98. 1817.—*Fimbristylis tetragona* R. Br.
tetragonus Poir. Encyc. Meth. 6: 767. 1804.—*Fimbristylis miliacea* (L.) Vahl
tetragonus Roxb. Fl. Ind. ed. Carey & Wahl. 1: 1820.
tetraquetrus O. Ktze. Rev. Gen. Pl. 1: 757. 1891.—*Eleocharis alta* Boeck.
tetraqueter (Nees) Thw. Enum. Pl. Zeyl. 454. 1864.—*Eleocharis tetraquetra* Nees
thermalis Spruce in Benth & Hook. f. Gen. Pl. 3: 1051. (S. Am. # Monocephales)
thermalis Trab. Bott. & Trab. Fl. de l'Alger. (monoc.) 99. 1895.—*S. pectinatus* Roxb.
thomasii Gay in Boeck. Linnaea 36: 459. 1870.—*Eleocharis atropurpurea* Kunth
thomsonii (Boeck.) O. Ktze. Rev. Gen. Pl. 1: 758. 1891.—*Eleocharis afflata* Steud.
thouarsi R. & S. Syst. Veg. 2: 134. 1817; Spreng. Syst. Veg. 4. cur. post. 27. 1827.—*S. sulcatus* Thouars.
thouarsianus Schult. in R. & S. Syst. Veg. 2: mant. 84. 1824. (# Isolepis)
thuarsii Spreng. Syst. Veg. 4: cur. post. 27. 1827.—*S. thouarsi* R. & S.
thunbergianus (Nees) Levyns, Jour. South Afr. Bot. 10: 28. 1944.
thunbergii (Schrad.) Boeck. Linnaea 36: 719. 1870.—*S. holoschoenus* L.
thunbergii Spreng. f. Tent. Suppl. Syst. 4. 1828.
thwaitesii Boeck. Linnaea 38: 381. 1874.—*Fimbristylis thwaitesii* (Boeck.) comb. nov.
thyrsiflorus Willd. Enum. Hort. Berol. 1: 78. 1809.—*S. cyperinus* (L.) Kunth var. *eriophorum* (Michx.) O. Ktze. & *S. cyperinus* (L.) Kunth
timorensis Kunth, Enum. Pl. 2: 162. 1837.—*S. erectus* Poir.
tomentosus Poir. Encyc. Meth. Suppl. 5: 101. 1817.—*Fimbristylis diphylla* (Retz.) Vahl
torreyanus (Boeck.) O. Ktze. Rev. Gen. Pl. 1: 758. 1891.—*Eleocharis microcarpa* Torr.
torreyi Olney, Proc. Prov. Franklin Soc. 1: 32. 1847. (N. Am. # Schoenoplectus)
tortilis Link, Jahrb. d. Gew. 1: 78. 1820; Willd. in Link, Enum. Pl. 2: 144. 1837.—*Eleocharis tortilis* (Link.) Schultes
trachycaulos Phil. Anal. Univ. Chile 93: 482. 1896. (# Androcoma)
trachyspermus (Nees) Clarke, in Dur. & Schinz, Consp. Flor. Afr. 5: 633. 1895.—*S. cernuus* Vahl
tranquebariensis Roth, Catalect. 3: 6. 1806.—*Fimbristylis ferruginea* (L.) Vahl
transiens K. Schum. in Engl. Abh. Preuss. Acad. Wiss. 38: 1894, nomen.
translucens LeGall. in Lloyd. Fl. Loire-Inf. 275. 1844; Congr. Sc. Fr. 16: I. 146. 1850.—*Eleocharis parvula* (R. & S.) Link
transvaalensis Boeck. in Clarke in Dur. & Schinz. Consp. Fl. Afr. 5: 163. 1894.—*Bulbostylis cinnamomea* (Boeck.) Clarke
trapezoides Koidz. Bot. Mag. Tokyo 39: 26. 1925.
trialatus Boeck. Flora 41: 445. 1859.—*Cyperus diffusus* Vahl var. *baucanus* (Miquel) Kük.
triangularis Steud. Nom. ed. I. 752. 1841.—*S. americanus* Pers. var. *triangularis* (Pers.) Beetle
triangularis MacMill. Metasp. Minn. 99. 1892.—*S. americanus* Pers. var. *triangularis* (Pers.) Beetle
triangulatus Roxb. Hort. Beng. 81. 1814, nomen; Fl. Ind. ed. Carey & Wall. 1: 219. 1820.—*S. mucronatus* L.
tricarinatus Pers. Syn. Pl. 1: 68. 1805.—*S. mucronatus* L.
trichobasis Baker, Jour. Linn. Soc. 20: 298. 1883.—*Bulbostylis trichobasis* (Baker) Clarke
trichocaulos Phil. Anal. Univ. Chil. 93: 478. 1896.—*S. inundatus* (R. Br.) Spreng.
trichodes Balb. in Boeck. Linnaea 36: 410-414. 1870.—*Eleocharis tenuissima* Boeck.
trichodes Ell. Sk. Fl. S. Car. 1: 76. 1816.—*Eleocharis acicularis* (L.) R. & S.
trichodes Muhl. Desc. Gram. 30: 1817.—*Eleocharis acicularis* (L.) R. & S.
trichoides H. B. K. Nov. Gen. et Sp. 1: 225. 1816.—*Eleocharis trichoides* (H.B.K.) Kunth

trichophorum Asch. & Graebn. Syn. Mitteleurop. Fl. 2: ab. 2, 301. 1904. = *S. hudsonianus* (Michx.) Fern.
trichophyllus Willd. in Kunth, Enum. Pl. 2: 224. 1837.—*Fimbristylis vahlii* (Lam.) Link
tricostatus (Torr.) O. Ktze. Rev. Gen. Pl. 1: 758. 1891.—*Eleocharis tricostata* Torr.
tridentatus Roxb. Hort. Beng. 81. 1814, nomen; Roxb. Fl. Ind. 1: 228. 1820.—*S. tuberosus* Desf.
triflorus (Vahl) Poir. Encyc. Meth. Suppl. 2: 249. 1817.—*Rhynchospora triflora* Vahl
triflorus (L.) O. Ktze. Rev. Gen. Pl. 3: II. 337. 1898.—*Cyperus triflorus* L. or *Fimbristylis tristachya* Thw.
trigonus Roth, Neue Beytr. 1: 90. 1802.—*S. triqueter* L.
trigonus Nolte, Novit. Fl. Holsat. 9. 1826.—*S. lacustris* L.
trigynus L. Mant. 2: 180. 1771.—(see *S. bulbosa* Rottb.)—*Ficinia trigyna* (L.) Pfeiff.
triqueter Gren. & Godr. Fl. Fr. 3: 373. 1855.—*S. littoralis* Schrad.
triqueter L. Mant. 1: 29. 1767. (Eurasia # Pterolepis)
var. *conglomeratus* Doll. Rhein. Fl. 163. 1843. = *S. triqueter* L.
var. *segregata* Clarke in Hook. f. Fl. Brit. Ind. 6: 658. 1894.—*S. triqueter* L.
var. *triangularis* Pers. Syn. Pl. 1: 91. 1805.—*S. americanus* var. *triangularis* (Pers.) Beetle
triqueter Michx. Fl. Bor. Amer. 1: 47. 1803.—*S. americanus* Pers.
triqueter Roth, Neue, Beitr. 1: 91. 1802.—*S. americanus* var. *triangularis* (Pers.) Beetle
triqueter Torr. Pacif. Rail. Rep. 4: 153. 1857.—*S. chilensis* Nees & Mey.
trispicatus L. f. suppl. 103. 1781.—*Ficinia trispicata* (L. f.) Pfeiff.
trispicatus Thunb. Prof. Pl. Cap. 17. 1794.—*Ficinia trispicata* (L. f.) Pfeiff.
trispicatulus Boeck. in Clarke in Dur. & Schinz. Consp. Fl. Afr. 5: 613. 1895.—*Bulbostylis collina* Clarke
tristachyos Boj. Hort. Maruit. 383. 1837.—*Bulbostylis barbata* (Rottb.) Clarke
tristachyos Rottb. Desc. Pl. Rar. Ic. 48. 1773. L. f. Suppl. 103. 1781.—*Ficinia tristachya* (Rottb.) Nees
tristachyos Roxb. Hort. Beng. 6. 1814; Roxb. Fl. Ind. ed. Carey & Wall. 1: 221. 1820. *Fimbristylis ferruginea* (L.) Vahl
tristachyos Vahl in Kunth, Enum. Pl. 2: 254. 1837.—*Ficinia*
tristachyos Zoll. in Steud. Syn. Pl. Glum. Pars. II. Cyp. 96. 1855.—*S. supinus* L. var.
truncatus Siebr. in Nees in Endl. Prod. Fl. Norfolk 23. 1833. Siebr. in Kunth, Enum. Pl. 2: 254. 1837.—*Ficinia lateralis* (Vahl) Kunth
truncatus Thunb. Prod Pl. Cap. 17. 1794.—*Ficinia truncata* (Thunb.) Schrad.
tuberculatus Ell. Sk. Fl. S. Car. 1: 78. 1816.—*Eleocharis tortilis* (Link) Schultes
tuberculatus Beyr. in Kunth, Enum. Pl. 2: 145. 1837.—*Eleocharis tortilis* (Link) Schultes
tuberculosus Michx. Fl. Bor. Am. 1: 30. 1803.—*Eleocharis tuberculosa* (Michx.) R. & S.
tuberculosus Willd. in Boeck. Linnaea 36: 446. 1870.—*Eleocharis melanocarpa* Torr.
tuberosus Roxb. Hort. Beng. 6. 1814, nomen; (Pl. Corom. 3: 25. t. 231.); Roxb. Fl. Ind. 1: 213. 1820.—*Eleocharis dulcis* (Burm. f.) Trin.
tuberosus Desf. Fl. Atl. 1: 50. 1798. 1800. (Old World # Bolbochoenus)
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umbellatus Noronha, in Thouars, Prod. Phyt. 2, in Meland. 1811, nomen.
umbellatus Roxb. in Kunth, Enum. Pl. 2: 294. 1837.—*Rhynchospora aurea* Vahl

umbellatus (Rottb.) O. Ktze. Rev. Gen. Pl. 3. II. 337. 1898.—*Fuirena umbellata* Rottb.
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var. *hallii* (Gray) Beetle, Am. Jour. Bot. 29: 656. 1942.—*S. supinus* var. *hallii* Gray
urvillei Boeck. Linnaea 36: 510. 1870.—*S. inundatus* Poir.

vaginatus (L.) Salisb. Prod. 31. 1796.—*Eriophorum vaginatum* L.
vaginatus Thunb. Prod. Pl. Cap. 17. 1794.—*Ficinia bulbosa* Nees
vahlii Lam. Illustr. 1: 139. 1791.—*Fimbristylis vahlii* (Lam.) Link
vahlii (H.B.K.) Link, Jahrb. de Gew. 1: 3. 81. 1820.—*Fimbristylis vahlii* (Lam.) Link
vahlii Willd. in Kunth, Enum. Pl. 2: 85. 1837, nomen.—*Cyperus filifolius* Willd. in Kunth
valdivianus (Phil.) O. Ktze. Rev. Gen. Pl. 1: 757-758. 1891.—*Eleocharis valdivianus* Phil.
validus Vahl, Enum. Pl. 2: 268. 1806; Vahl in Benth. Pl. Hartw. 27. 1839. (N. Am. & Pan-Pacific # Pterolepis)
var. *condensatus* (Peck) Beetle, Univ. Wyoming Publics. 13: 6. 1948.
var. *condensatus* (Peck) Beetle f. *creber* (Fern.) Beetle, Univ. Wyoming Publics. 13: 6. 1948.
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varius Boeck. in Clarke in Dur. & Schinz. Consp. Fl. Afr. 5: 634. 1895, nomen; Clarke in Dyer, Fl. Cap. 7: 229. 1898.
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verrucosulus (Nees) Steud. Flora 12: 145. 1829. (Afr. # Eleogiton)
vestitus Reichenb. in Boeck. Linnaea 36; 753. 1870.—*Bulbostylis vestita* (Kunth) Clarke
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virens Boeck. Flora 58: 261. 1875.—*Bulbostylis*
viridis (Boeck.) O. Ktze. Rev. Gen. Pl. 1: 758. 1891.—*Eleocharis viridis* Boeck.
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wallrothii Bernh. Flora 8: 607. 1825.—*Nomochloa rufa* (Huds.) Beetle
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zollingeri O. Ktze. Rev. Gen. Pl. 1: 758. 1891.—*Eleocharis subprolifera* Steud.

A New Dracontium from Southern Mexico

Eizi Matuda
Matuda Herbarium, Escuintla, Chiapas, Mexico

Dracontium soconuscum Matuda, sp. nov.—Planta tuberosa unifoliata; folia decidua; petiolo 50-70 cm. longo cylindrico semisucculente rufescente notato verrucoso; bracteis caducis; lamina tripartita incisa 40-60 cm. longa, 30-40 cm. lata; pedunculis 10-15 cm. longis, 0.5 cm. diam., cylindricis; spatha membranacea purpurea concava 10-12 cm. longa, 5-6 cm. lata, persistente; spadice 3-4 cm. longo 0.7-1 cm. diam. cylindrico ad apicem rotundato; floribus hermaphroditicis parvis ca. 2 mm. longis; tepalis 7 vel 6; staminibus 7 vel 6.

The mature spathe has 8 to 10 main parallel veins and is net veined between. The tepals are 1-1.2 mm. broad and 2-2.5 mm. long, the upper parts truncate and inclined toward the floral center. From the inner base of each tepal rises one stamen on which there are two oblong two-celled anthers. The stigma is round, sessile; the ovary 4-celled. The ovary and stigma together are 3-3.5 mm. long. Local name: *Cola de Tigre.*

MEXICO: CHIAPAS, in lowland thickets or bush of Santa Elena, 16 km. west of Acapetagua, Distrito of Soconusco, at about 30 m. altitude; *Matuda* No. 17780, type in Matuda Herbarium; isotypes in the Instituto de Biologia of Mexico and Chicago Natural History Museum. Collected also at (1) Nandolopez in the same Municipality, near the beach of Pacific coast lowland, at (2) Aguas Calientes, near Escuintla, and at (3) Laguna de Cruz de Piedra, near Acacoyagua, at about 100 m. altitude.

This is the first record of this genus from Mexico and it seems that this marks the northern limit of the distribution of this genus in America. The tuber is hemispheric; from the upper surface extend the roots, the lower rounded surface is always smooth and without any roots. It flowers in February and March, the dry season of the region, and at that time is without leaf. The leaf is borne only in the rainy season from May to October. No local utilization of the tuber has yet been discovered. In his *Flora of the Panama Canal Zone* Standley gives (p. 101) "Flower without perianth" as the character of the genus *Dracontium*, but this is apparently an accidental slip on the part of an ordinarily exact writer.

The present writer feels particularly indebted to Dr. Harold N. Moldenke of the New York Botanical Garden, for his numerous favors especially with Latin diagnoses.

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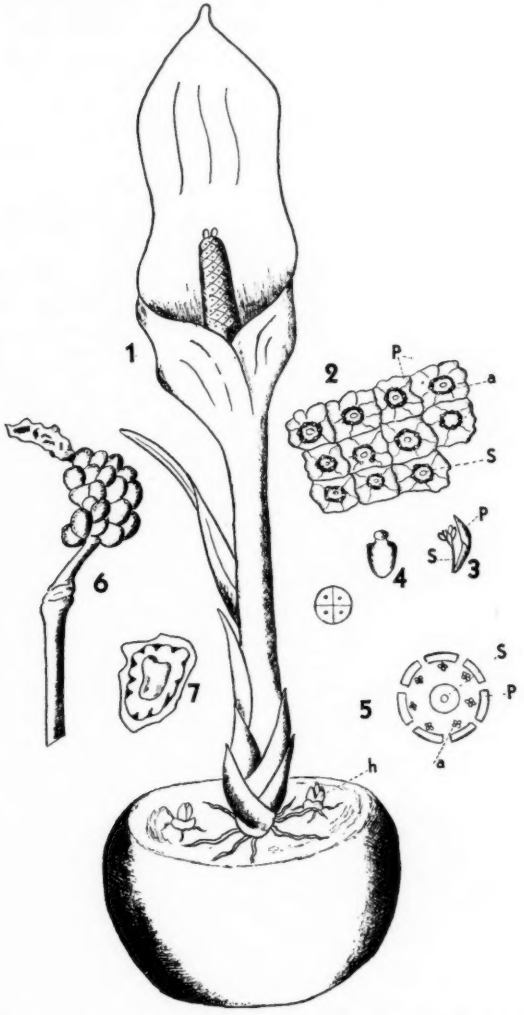

Fig. 1-7. *Dracontium soconuscum* Matuda.—1. General aspect of tuber and flower, × 3/5; 2. Surface of spadix, × 5.5 (complete flower shown); 3. Perianth and staminate flower, × 3; 4. Female flower, stigma and ovary, horizontal section of ovary, × 2.4; 5. Floral structure, × 6; 6. Fruit, × 3/5; 7. Vertical section of a seed. Abbreviations: a—anthers; h—leaf bud; P—perianth; S—stigma (fig. 2), staminate flower, filament and anthers (fig. 3), stigma and ovary (fig. 5). Magnifications are approximate.

Pugillus Astragalorum X: New Species, Varieties and Combinations

R. C. Barneby
Wappinger Falls, New York

While the present notes are based principally on plants obtained in the western States by H. D. Ripley and the writer, they owe at least as much to the generosity of other collectors. I am especially grateful for gifts and loans of *Astragalus* material communicated by Prof. Ray J. Davis, Pocatello, Prof. C. Leo Hitchcock and Mr. J. W. Thompson, Seattle, Dr. F. J. Hermann, Beltsville, and Prof. Morton E. Peck, Salem, and would also acknowledge my indebtedness to the curators for permission to study specimens preserved in the following herbaria: Gray Herbarium (G), University of Minnesota (M), New York Botanical Garden (NY), Pomona College (PO), University of Idaho, Southern Branch (UI) and University of Washington (UW).

Astragalus Whitedii Piper var. **brachycodon** Barneby, var. nov., a prole typica praesertim calyce (nigrostriguloso) corollaque brevioribus, illo 5—5.5 mm. tantum, carina circa 9 mm. longis, necnon legumine parvo glabro nitido absimilis.

OREGON: dry slope three miles north of Redmond, Deschutes Co., 2 July 1942, *M. E. Peck No. 21491*. Type in herb Willamette University No. 24037. Ten miles west of Millican, Deschutes Co., *M. E. Peck 18900* (W).

Throughout its wide range, which extends from the valley of the Columbia to the Snake River Plains and the easterly slope of the Californian Sierra, *A. Whitedii* is uniformly large-flowered, with calyx 8—10 mm. and keel 11—15 mm. long. Smaller flowers are occasionally borne on lateral branches late in the season, but they are not characteristic. The pod may sometimes become glabrate at maturity, but some trichomes are always found on the ovary and forming legume. The small-flowered variant with glabrous, shining pod described here seems almost specifically distinct, but Dr. Peck communicates two specimens from Harney County, Oregon (Narrows, *Nos. 3019, 3020*), which in corolla-size establish a passage to typical *A. Whitedii*. Since the legume in these is pubescent, it seems proper to refer the material to the species. In the fruiting type of var. *brachycodon* the body of the pod is scarcely more than lunate, but in the flowering plant from Millican the young legume is already arcuate through half a circle—a type of variation common in § *Collini*.

Astragalus castaneaeformis Wats. var. **consobrinus** Barneby, var. nov., a var. *typico* nob. corolla alba (nec ochroleuca), stipulis semper cano-pilosis (nec strigosis demum glabratis) ac praesertim legumine fere a medio in rostrum subrectum latum longius acuminato absimilis.

UTAH: sandy knolls southeast of Bicknell, Wayne Co., alt. 7600 ft., 10 June 1947, fl. & fr., *Ripley & Barneby No. 8605*. Type in herb. Calif. Acad. Sci. No. 337307. Gravelly knoll in sagebrush valley two miles south of Angle, Piute Co., alt. 6000 ft., *No.*

8600. Cobblestone bluff five miles north of Hatch, Sevier Co., alt. 7000 ft., *No. 8536* (a single plant seen). Ivie Creek, Sevier Co., alt. 6600 ft., No. *4749.*

The last collection cited was referred in my revision of § *Argophylli*[1] to *A. castaneaeformis,* though it was noted as being somewhat anomalous. The very uniform material now at hand shows that the species is represented in the plateau region of central Utah by a race which, although not distinguished by strong technical characters, is a definite and recognizable entity. In addition to the criteria contrasted below, the var. *consobrinus* usually differs in the coarser quality of the dolabriform hairs, in its yet more condensed habit, and in the absence of suffrutescent caudex-branches even in old plants. It seems to be confined to open knolls, whereas the typical form is characteristically, perhaps exclusively, a denizen of yellow pine forest, a habitat occupied in Utah by the related and similar *A. panguicensis* Jones.

KEY TO THE VARIETIES OF A. CASTANEAEFORMIS

1. Pod with short conical or deltoid beak much shorter than the obcompressed body; stipules loosely strigose, becoming glabrate in age; corolla ochroleucous or with some infusion of sordid purple in all the petals; open forests of the Kaibab Plateau and about the San Francisco Peaks in Coconino Co., Arizona .....var. *typicus*[2]

1. Pod strongly flattened laterally above the middle into a broad and conspicuous beak as long or nearly as long as the obcompressed body; stipules permanently and densely white-pilose, their surface concealed by the vesture; corolla white, except for a faint purple spot on the keel; open knolls and bluffs on the plateaux of central Utah .....var. *consobrinus*

ASTRAGALUS WOOTONI Sheld., SENSU AMPLIATO

While preparing descriptions for the two new varieties indicated below, it has become clear that a reappraisal of the related forms is long overdue. As I understand them, the elements of the species may be arranged according to the following key, to which is appended a condensed view of the synonymy and distribution.

KEY TO THE VARIETIES OF A. WOOTONI

1. Flower very small, the calyx-tube 2-2.5 mm., the keel-petals 6 mm. long or less.
  2. Herbage strigose, the hairs strictly appressed.
    3. Leaflets (except in some early leaves or in obviously depauperate specimens) 6-9 pairs; peduncles borne in median axils upwards, stout, (1.8) 2.5-5 cm. long; pod chartaceous, usually unmottled, the ventral suture filiform or raised within as an obscure wing 0.6 mm. wide or less .....var. *typicus*
    3. Leaflets 4-5 pairs; peduncles borne through nearly the whole length of the stem, subfiliform, 1.5-2 cm. long; pod membranous, diaphanous, mottled, the ventral suture produced inward as a wing 2.5-4 mm. broad .....var. *endopterus*
  2. Herbage loosely pubescent or villous with incurved or spreading hairs.
    4. Leaflets 7-11 pairs; central and southern Mexico .....var. *Candolleanus*
    4. Leaflets 3-7 pairs; Death Valley, California .....var. *morans*
1. Flower larger, the calyx-tube 3-3.5 mm., the keel-petals 8-8.5 mm. long. East-central Idaho .....var. *aquilonius*

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1 Amer. Midl. Nat. 37: 435. 1947.

2 *A. castaneaeformis* Wats. var. *typicus,* nom. nov. *A castaneaeformis* Wats., Proc. Amer. Acad. 20: 361. 1885.

a. *Astragalus Wootoni* Sheld. var. **typicus**, nom. nov. *A. Wootoni* Sheld., Minn. Bot. Stud. 1: 138. 1894. Type: Las Cruces, New Mexico, *Wooton in 1892*, M! *A. playanus* Jones, Contrib. West. Bot. 8: 6. 1898. Type: El Paso, Texas, *Jones in 1892*, PO! *Phaca Tracyi* Rydb., N. Amer. Fl. 24: 351. 1929. Type: Toyah Creek, western Texas, *Earle & Tracy No. 78*, NY! *Astragalus triflorus* sensu Gray, Pl. Wright. 2: 45. 1853, non *Phaca triflora* DC.—Northern Arizona and adjacent California to western Texas and Durango. *Phaca Tracyi* (*Astragalus Tracyi* (Rydb.) Cory) seems to be no more than a vernal, depauperate form.

b. **Astragalus Wootoni** var. **Candolleanus** (H. B. K.) Barneby, comb. nov. *Phaca Candolleana* H. B. K., Nov. Gen. & Sp. 6: 395. 1824. Type: Volcán Jurullo, Michoacan, *Humboldt*, not seen. *Astragalus Candolleanus* (H. B. K.) Sheld., Minn. Bot. Stud. 1: 140. 1894; non *A. Candolleanus* Royle (1835), nec Bss. (1843). *A. triflorus* var. *Candolleanus* (H. B. K.) Jones, Proc. Calif. Acad. Sci. ser. 2, 5: 637. 1895. *Phaca zacatecana* Rydb., N. Amer. Fl. 24: 352. 1929. Type: Casualidad, Zacatecas, *Jones in 1892*, NY! — Valley of Mexico to Michoacan and San Luís Potosi. The long persisting confusion of the Mexican *Phaca Candolleana* with the perfectly distinct Peruvian *P. triflora* DC. has been lately discussed by Johnston.[3]

c. **Astragalus Wootoni** var. **endopterus** Barneby, var. nov., a var. *typico* nob. foliolis minus numerosis (4—5-jugis), pedunculis brevioribus in axillis fere infimis et inde per totam caulis longitudinem gestis, et praesertim leguminis sutura ventrali intus producta alam 2.5—4 mm. latam efformanti valvulisque tenuioribus diaphanis maculatis recedens.

ARIZONA: sandy bed of the Little Colorado River, at Cameron, Coconino Co., alt. 3700 ft., 5 June 1947, fl. & fr., *Ripley & Barneby No. 8491*. Type in herb. Calif. Acad. Sci. No. 337308. Twelve miles below Tanner's Crossing, Little Colorado, *L. F. Ward in 1901* (NY).

The variety *endopterus* is perhaps no more than a local modification of the widespread var. *typicus*, but its technical peculiarities are too numerous to ignore, and its general aspect is distinctive. The appearance of peduncles in even the lowermost axils, where they are at times paired with a lateral branch, recalls *A. Geyeri* Gray; but the ellipsoid pod is essentially of the *Wootoni* alliance. In the inward production of the ventral suture and in the membranous texture of the valves, var. *endopterus* resembles *A. Wardii* Gray; but this differs in being nearly glabrous throughout, the pod wholly so, and in the numerous and much smaller leaflets.

d. **Astragalus Wootoni** var. **morans** (Crum) Barneby, comb. nov. *A. triflorus* var. *morans* Crum in Jeps., Fl. Calif. 2: 355. 1936. Type: Hanaupah Canyon, Panamint Mts., California, *Coville & Gilman No. 44*, not seen. *A. Gilmani* Tidestr., Proc. Biol. Soc. Wash. 50: 20. 1937. Type. Death Valley Canyon, Panamint Mts., *Gilman No. 1871*, not seen. — Apparently a narrow endemic of the mountains bordering Death Valley to the west. The following collections, all from canyons in the Panamints and agreeing closely with the descriptions of *A. triflorus* var. *morans* and *A. Gilmani*,

3 Jour. Arnold Arb. 28: 391, 392. 1947.

have been studied: *Munz No. 14800, Gilman No. 2488, No. 2645* (all PO).

e. **Astragalus Wootoni** var. **aquilonius** Barneby, var. nov., ab omnibus speciei formis calyce corollaque manifeste majoribus, illius tubo 3—3.5 mm., hujus vexillo 9—11 mm. ac carina 8—8.5 mm. longis, a var. *typico* pubeque patula villosa absimilis.

IDAHO: four miles south of Lemhi, Lemhi Co., *Hitchcock & Muhlick No. 9218.* Type in herb. Univ. Washington. Baker, Lemhi Co., *Jones* (PO). Across river from Challis, Custer Co., *Hitchcock & Muhlick No. 8931* (UW). Eight miles east of Clayton, Custer Co., *Ripley & Barneby No. 8836.* Ten miles below Clayton, *R. J. Davis No. 489* (UI).

Jones[4] referred his collection of var. *aquilonius* to an inclusive "*A. triflorus,*" and with its villous pubescence it much resembles the Mexican var. *Candolleanus.* However the corolla is considerably larger and the pod, which may be either glabrous from the first or strigillose with short, appressed hairs, is longer and wider than all but a few exceptionally robust examples of the Mexican race. In the dimensions of the corolla and legume var. *aquilonius* approaches the cismontane Californian *A. Douglasii* Gray, but the short-lived perennial or perhaps winter annual root suggests a closer relationship with *A. Wootoni.* Since no member of the *Wootoni* complex is known to range north of the Arizona-Utah border, var. *aquilonius,* confined to the canyons of the upper Salmon River and its tributaries, presents a marked instance of geographic isolation, and perhaps on these grounds alone might be conveniently maintained as a distinct species. But the morphological differences are slight.

Astragalus microcymbus Barneby, sp. nov., *Strigulosis Astragali* Jones seu *Atelophragmatis* Rydb. juxta *A. cobrensem* Gray addenda, ab hac statura saltem duplo majori, habitu ramoso, pedunculis brevioribus et praesertim legumine minori omnino 1-loculari (nec semibiloculari) manifeste dissimilis.

Herba perennis diffusa pluricaulis, pube brevi pilosula basifixa fere undique cinerascens; caulibus e collo radicis subterraneo ortis prostratis et assurgentibus 5 dm. longis et ultra, flexuosis, fere e basi divaricatim ramosis, striatis laxiuscule strigosis; stipulis 3-angularibus reflexis, mediis imisque truncatis breviter connatis; foliis patulis vel subreflexis 2—4 cm. longis; foliolis 7-jugis secus rachin gracillimum sulcatum vix decrescentibus, petiolulatis obovato-oblongis emarginatis basi cuneatis 3—8 mm. longis, 2—3 mm. latis, conduplicatis inferne pilosulis pallidis, superne glabrescentibus saturatius viridibus; racemis primorum internodii foliique abortu quasi aphyllopodiis, vel internodiis ramulorum ultimorum 1—3 suppressis quasi conjugatis fasciculatisve; pedunculis folio suffulcranti plerumque dimidio brevioribus in racemum (3) 7—14-florum, fructiferum laxum (1) 2—4 cm. longum abeuntibus; bracteis ovatis circa 1 mm. longis scariosis ciliatis pedicello patulo-recurvo subaequilongis; corolla pallide purpurascenti; calycis villis albis atrisque commixtis pilosuli tubo ebracteolato obconico-campanulato 2 mm. longo, demum haud vel ad medium

4 Rev. Astrag. 105. 1923.

usque ventraliter fisso, dentibus subulatis circa 1 mm. longis; vexillo 6 mm. longo, supra unguiculum perbrevem in laminam ovatam emarginatam 3 mm. latam abrupte expansa; alis 5—5.5 mm. longis, lamina oblique oblonga emarginata 1.7 mm. lato, auriculo incluso 4 mm. longa; carinae 4 mm. longae laminis subquadratis 2.5 mm. longis, fere 2 mm. latis, marginibus ventralibus subrectis, inferioribus per 100° in apicem rectangularem abrupte incurvis; ovario 4—6-ovulato; legumine pendulo ellipsoideo utrinque acuto, ad basin in stipitem brevissimum subobsoletum angustato, dorsiventraliter compresso, 7—9 mm. longo, 2.5—3 mm. lato, suturis ventrali prominula tota longitudine convexa, dorsali concavo-depressa sulcum latum atque apertum percurrenti (ut legumen resupinatim cymbiforme videtur), valvulis chartaceis obscure reticulatis albopilosulis stramineis purpureo-guttulatis, nequaquam introplicatis nec inflexis; seminibus 2—4, ellipsoideis compressis 2.9—3.1 mm. longis atris nitidis ruguso-punctatis.

COLORADO: sandy roadside, four miles west of Gunnison, Gunnison Co., alt. 7700 ft., 20 July 1945, fl. & fr., *Ripley & Barneby No. 7179*. Type in herb. Calif. Acad. Sci. No. 326695.

By strict application of Rydberg's key to the astragaline genera[5] *A. microcymbus* keys out to *Phaca*, and thence to subgen. *Chartocystis* § *Microcystes*, but no one who has compared it with *A. cobrensis* Gray, of Rydberg's genus *Atelophragma*, can doubt its relationship to that member of the largely Mexican group *Strigulosi*, in spite of its unilocular legume. It is interesting to recall that another species, the Chihuahuan *A. quinqueflorus* Wats., referred by Rydberg to *Phaca* § *Microcystes*, likewise finds its nearest relative among the *Strigulosi* in *A. Brandegei* Porter. In the latter case Rydberg clearly placed exaggerated confidence in the presence of a septum as a criterion of affinity, and thereby arrived at an unnatural classification. From *A. cobrensis*, with which it accords in the shape, compression and texture of the pod, *A. microcymbus* differs in its greater stature, diffuse mode of branching, shorter peduncles and smaller (unilocular) legume. Geographically it is remote, *A. cobrensis* being confined to the mountains of southwestern New Mexico and (as a variety) adjacent Arizona.

The geminate racemes, anomalous in the *Strigulosi*, are quite curious, a similar phenomenon having been observed elsewhere only in *A. tenellus* Pursh and *A. Lemmoni* Gray, species closely allied neither to each other nor to *A. microcymbus*. At most of the upper nodes an ordinary peduncle is produced, as well as one or more subsidiary racemes arising from between it and its subtending leaf. Similarly at the median nodes, whence arise the principal lateral branches, we find an auxiliary branchlet, or sometimes a naked peduncle, inserted in an equivalent position, presenting an apparently trichotomous mode of ramification. This pairing of the peduncles (or, below, of the branches, or of branch and peduncle together) results from the suppression of one or more internodes and leaves of an axillary branchlet. Since this occurs only occasionally in *A. tenellus* and *A. Lemmoni*, it will probably not be found characteristic of *A. microcymbus* either.

5 N. Amer. Fl. 24: 251. 1929.

Astragalus eremiticus Sheld. var. **malheurensis** (Heller) Barneby, comb. nov. *A. malheurensis* Heller, Cat. N. Amer. Pl., Ed. 2, 7, 1900. *Tium malheurense* (Heller) Rydb., N. Amer. Fl. 24: 391. 1929. All based on *Astragalus Cusickii* Rydb., Bull. Torrey Club 26: 581. 1899; non Gray (1878).

OREGON: Malheur, *Cusick No. 1238* (G, type). The Slides, Malheur Co., *R. C. Bunn No. 1465*. Sucker Creek, Malheur Co., *R. C. Bunn No. 1471* (this and the preceding in the herbarium of the writer, commun. J. W. Thompson). IDAHO: southwest of Marsing, Owyhee Co., *Ripley & Barneby No. 6143* (G, NY). Given Springs, Owyhee Co., *Piemeisel No. 40-598* (in herb. F. J. Hermann).

I have formerly alluded[6] to *A. malheurensis* as "an ecological variant with linear leaflets" occurring with var. *spencianus* Jones about the common boundary of southern Idaho and Oregon. Further collections now available suggest that it is better interpreted as a geographical entity, endemic to the bare clay hills of the region, and worth maintaining as a variety. The linear leaflets and often purple flower set it apart from var. *spencianus*, with which it has in common all characters of habit, flower and pod.

Astragalus amblytropis Barneby, sp. nov. ab acaulescenti *A. platytropidi* Gray, cui soli affinis, caulibus extensis ramosis omnino herbaceis e subterraneo radicis collo (nec e caudice caespitoso petiolis marcescentibus induto) ortis, stipulis minoribus brevius connatis, aliisque notulis procul abhorrens. Ab omnibus *A. lentiginosi* Dougl. (cujus legumen fere praebet) formis imprimis stipulis circa petiolum connatis, calyce companulato carinaque oblique truncata longius distat.

Herba perennis prostrata pube brevissima strigosa basifixa copiosa omnibus fere partibus cinerascens; caulibus paucis e subterraneo radicis verticalis collo assurgentibus, inferne simplicibus nudis, ad medium ramosis, 1—3 dm. longis, gracilibus abruptiuscule flexuosis strigosis saepe purpurascentibus; stipulis minimis deltoideis 0.5—2 mm. longis, erectis reflexisve, circa petiolum brevissime coalitis, altrinsecus subliberis vel linea stipulari conjunctis, herbaceis demum chartaceis casteneisque; foliis patulis 1.5—5 cm. longis, petiolo gracili 5—11 mm. longo; foliolis (2) 4—6-jugis confertis obovatis basi cuneatis profunde emarginatis 3—9 (12) mm. longis saepe conduplicatis glaucescentibus, pilis brevissimis arcte appressis utrinque cinereis; pedunculis patulis 0.6—3 cm. longis; racemis laxiuscule 4—11-floris, fructiferis 0.5—2 cm. longis; pedicellis gracillimis patentibus bractea subulata aequilongis vel duplo longioribus; calycis cinereo-strigosi tubo campanulato ebracteolato demum rupto 2—2.5 mm. longo, dentibus subulatis erectis 1.5—2 mm. longis; corolla sordide ochroleuca vel purpurascenti, carinae petalis gutta pulla instructis; petalis aequilongis (vel vexillo latissime obovato vel supra unguiculum suborbiculari emarginato aliis paullo breviori) 6.5—8 mm. longis; alarum lamina oblique lunata, auriculo incluso 6—7 mm. longa, iis carinae prominulae circa 5.5 mm. longis, 2—3 mm. latis, semiobovatis, marginibus inferioribus per angulum rectum in apicem latum obtusissimum abrupte incurvis; legumine patulo sessili tarde deciduo

6 In Davis, Contrib. Fl. Ida. 51: 25. 1947.

ovoideo vesicario-inflato obscure obcompresso in rostrum perbrevem deltoideum 1-locularem abrupte contracto, 2—3.3 cm. longo, secus utramque suturam leviter sulcato, valvulis tenuiter chartaceis subdiaphanis strigulosis demum stramineis immaculatis sed plus minusve purpurascentibus dorsaliter profunde introflexis ut septum ad medium legumen completum 3—6 mm. latum efformet; ovulis numerosis, funiculis per alam angustam membranaceam e sutura ventrali intus productam excurrentibus; seminibus 3—3.5 mm. longis, ochraceis interdum purpureo-guttulatis.

IDAHO (all but the last from Custer Co.): shale cliffs ten miles west of Clayton, 28 June 1946, fl. & fr., *Hitchcock & Muhlick No. 14115*. Type in herb. Univ. Washington. Loose clayey hillsides near Challis, *Macbride & Payson No. 3340* (NY). Four miles south of Challis, *Ripley & Barneby No. 8825*. Nine miles north of Challis, No. *8839*. Twenty-nine miles south of Salmon, Lemhi Co., *No. 8844*.

Macbride and Payson distributed their collection of *A. amblytropis* from Challis as a new species, but Rydberg referred it (in herb.) to *A. platytropis* Gray, and it thus remained undescribed. Clearly its affinities do lie with *A. platytropis*, of which it has almost exactly the flower, and of which it might easily be interpreted as a lowland, caulescent phase. However it differs not only in the developed stem, but also in the subterranean root-crown, the absence of a cespitose aerial caudex, in the quality of the vesture, the form of the stipules and the narrow inward production of the pod's ventral suture. Moreover *A. platytropis* itself, although largely subalpine, occasionally descends into the Arid Transition zone (e.g. north of Melrose, Silver Co., Mont., alt. 5500 ft., *Ripley & Barneby No. 8132*) and there retains its acaulescent habit and other distinctive features.

The addition of *A. amblytropis* to § *Orocystium* considerably weakens the characters originally assigned to that section,[7] since the pod is technically indistinguishable from that of § *Diphysi* Gray (*Diplocystium* Barneby), and the connation of the stipules behind the petiole is less extreme. Nevertheless the form of the stipules, the subequal petals with the prominent and broad, obliquely truncate keel, and the truly campanulate calyx remain to distinguish both *A. amblytropis* and *A. platytropis* from any part of *A. lentiginosus*.

Astragalus amblytropis is not uncommon along the canyon of the Salmon River for a distance of about thirty miles above and below Challis, where it occurs on bluffs of loose clay or shale and on mobile slides of fine basaltic gravel, with an altitudinal range of approximately 4600 and 5600 feet. The plants are found only on the steepest banks where the prostrate stems, springing from a root-crown deeply buried in the shifting talus, form irregular lacy mats or hang down in graceful, divaricately branching sprays. The neat silvery foliage, tiny fawn-colored or occasionally purplish flowers and the enormous bladders of the fruit form a striking and unique combination.

7 Cf. Barneby, Proc. Calif. Acad. Sci. ser. 4, 25: 166. 1944.

Some Interesting Plant Records from Trans-Pecos, Texas

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In the course of almost fifteen years of plant collecting in Trans-Pecos Texas some interesting records have been obtained. A few undescribed species of plants have been discovered. A few other species not previously recorded for the United States and a larger number new to Texas have been found. Besides these records, the limits of several species have been noted. Undoubtedly future collections will bring other interesting facts to light.

PTERIDOPHYTA

Cheilanthes villosa Davenp.—This species was first collected on a cliff along the north fork of Palo Blanco Creek, Sierra Tierra Vieja, in western Presidio County. Though somewhat rare, it has been collected in other localities of the Trans-Pecos.

Pellaea longimucronata Hook.—Collected at the northern end of the Quitman Mountains a few miles west of Sierra Blanca. It seems not previously recorded for Texas.

PINACEAE

Pinus cembroides Zucc.—Found in upper Musgrave Canyon, Sierra Tierra Vieja.

Pinus edulis Engelm.—Collected in H O Canyon of the Davis Mountains.

These two specimens have leaves commonly in 2's with a few of the fascicles with leaves in 3's. Counts have been made on many of the trees in Trans-Pecos Texas, and the same proportion of leaf numbers have been found. The tree of our area may be a transiton between the pinyon of Mexico and that of northern New Mexico.

GRAMINEAE

Festuca arizonica Vasey.—Found on top of Mt. Livermore in the Davis Mountains. It seems not before recorded for Texas.

BROMELIACEAE

Hechtia texensis Wats.—On sandstone hills near the mouth of Fresno Canyon, Bofecillos Mountains, southeastern Presidio County. This seems to be the western limit of the plant in the United States.

LILIACEAE

Yucca thompsoniana Trel.—In Tapado Canyon near the Rio Grande, southern Presidio County, and from the White Hills near Casa Piedra, both

stations in the Bofecillos Mountains. The localities are probably at the western limit of the species in the United States.

AMARYLLIDACEAE

Cooperia drummondii Herb.—Collected in a flat about one mile west of Butcherknife Mountain in Green Valley, Brewster County, and at Alpine. The western part of this county seems the western limit of the species in the United States, since it has not yet been found in Presidio County.

SALICACEAE

Populus arizonica Sarg.—In the bed of Arroyo Segundo, a branch of Fresno Canyon, in the Bofecillos Mountains of southeastern Presidio County; along the Rio Grande about four miles east of Redford in southern Presidio County; and at Plata on Alamito Creek about 35 miles south of Marfa.

Populus wislizeni (Wats.) Sarg.—Collected near Mexican Spring on the western side of Sierra Tierra Vieja, western Presidio County; in a branch of Pinto Canyon at the Watts ranch, Chinati Mountains; and in low Merrill Canyon about five miles southwest of Mt. Livermore.

The stations for these two species of cottonwoods are separated by a line running roughly from northwest to southeast through south central Presidio County.

FAGACEAE

Quercus livermorensis C. H. Muller.—In upper H O Canyon near Mt. Livermore. The species seems to be limited to the immediate locality.

Quercus turbinella Greene.—In low scrubby thickets along the western side of the Solitario, southern Presidio and Brewster counties. This is probably the eastern limit of the species.

Quercus vaseyana Buckl.—In the northern Chinati Mountains and southern Sierra Tierra Vieja. This seems to be the western limit of the species in the United States.

CHENOPODIACEAE

Bassia hyssopifolia (Pall.) Kuntze.—On Highway 80 in west Pecos. A weed on the street. Though apparently only recently introduced into Texas, this plant like its relative the Russian thistle, *Salsola pestifer,* seems to be spreading rapidly in Trans-Pecos Texas.

NYCTAGINACEAE

Anulocaulis reflexus Johnst.—In clay soil at Newman Spring, Sierra Tierra Vieja, western Presidio County. This seems to be the first collection of this species in the United States.

Mirabilis rotata Johnst.—In Fresno Canyon, southeastern Presidio County. This may be the northern limit of this Mexican species.

RANUNCULACEAE

Aquilegia chaplinei Standl.—At the waterfall in Arroyo Segundo, Bofe-

cillos Mountains, southeastern Presidio County. This is probably the southeastern limit of the species in the United States.

Aquilegia hinckleyana Munz.—In wet soil under Capote Fall, Sierra Tierra Vieja, western Presidio County. This is an isolated colony, for no other specimens were found in this range.

SAXIFRAGACEAE

Ribes aureum Pursh.—Just below San Esteban Lake near Marfa. This may be the southeastern limit of the species in the United States.

Ribes leptanthum Gray.—On the high northern slope of Mt. Livermore. This species seems to come no further southeastward in the United States.

LEGUMINOSAE

Dalea filiformis Gray.—On the high slopes of Mt. Livermore and adjacent ridges. This is probably near the southeastern limit of the species in the United States.

Peteria scoparia Gray.—In low Merrill Canyon southwest of Mt. Livermore. Somewhat rare in herbaria, but found in several localities in Presidio County.

Eysenhardtia spinosa Engelm.—In a canyon on the eastern slope of Capote Peak. Known previously only from Mexico.

EBENACEAE

Diospyros texana Scheele.—In a short canyon just northwest of La Mota ranch headquarters in the Bofecillos Mountains in southern Presidio County. This seems to be the western limit of the species in the United States.

EUPHORBIACEAE

Euphorbia bifurcata Engelm.—On the northern slope of Mt. Livermore. As yet this has been found in Texas only from this locality.

STERCULIACEAE

Melochia pyramidata L.—Above Burney's Mine on the southern slope of West Chinati Peak. This seems to be the first collection for Trans-Pecos Texas.

ONAGRACEAE

Oenothera havardii Wats.—The second collection from Texas was made at Marfa in 1936. Havard made the first collection about 1887.

UMBELLIFERAE

Osmorhiza bipatriata Lincoln Constance and Ren Hwan Shan.—On the northwestern slope of Mt. Livermore. A species only recently described.

POLEMONIACEAE

Gilia stewartii Johnst.—Just east of the road crossing Van Horn Creek in

western Presidio County. This species has been little collected in the United States.

Polemonium hinckleyi Standl.—In the gorge of high Madera Canyon on Mt. Livermore. This is apparently a new genus for Texas.

LABIATAE

Poliomintha glabrescens Gray.—In Burnt Camp Canyon of the Solitario, southeastern Presidio County. The second collection for the United States. The first was made by Havard at Maxon Springs.

Salvia tiliaefolia Vahl.—Along the street in front of my house in Marfa. Apparently the first record for the United States.

SCROPHULARIACEAE

Maurandya wislizeni Engelm.—On a sandy ridge along the Rio Grande in western Presidio County. This seems to be a first collection for Texas.

Mimulus dentilobus Rob. & Fern.—In Tapado Canyon, Bofecillos Mountains, southern Presidio County. The first collection for Texas and seemingly about the eastern limit of the species.

ACANTHACEAE

Carlowrightia serpyllifolia Gray.—In a short unnamed canyon on the southern side of the Chinati Mountains. It seems to be the first record for Texas.

COMPOSITAE

Brickellia hinckleyi Standl.—In Madera Canyon at the foot of Mt. Livermore.

Melampodium hispidum H. B. K.—Along Madera Creek at the scenic drive crossing. This seems a first collection for Texas.

Melampodium longicorne Gray.—In Madera Canyon about two miles northeast of Mt. Livermore. A first collection for Texas.

Schkuhria hopkirkia Wats.—On the eastern slope of Sierra Tierra Vieja. It seems to be a first collection for the United States.

Schkuhria pringlei Wats.—Along Madera Creek at the scenic drive crossing in the Davis Mountains. Apparently the first collection for Texas.

Additional Notes on Some Illinois Plants

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The vascular plants mentioned in this paper are divided into two groups, 1) a list consisting of the names of seven species, three of them natives and four adventive, not previously reported as occurring in Illinois, and 2) additional locality-records of plants already published as growing in this state. The second list includes nineteen native plants, and eight that are adventive. Unless otherwise indicated, specimens of these plants are in the herbarium of the Illinois State Museum. Some of the cited specimens are at the University of Illinois (UI), Chicago Natural History Museum (CM), and University of Wisconsin (UW).

I. Plants not Previously Reported for Illinois

Adoxa moschatellina L.—Moist limestone, Apple River Canyon, Jo Daviess Co., May 8, 1937, *N. C. Fassett 18709* (UW), June 18, 1937, *F. J. Hermann 8896* (CM).

Amelanchier interior Niels.—Tamarack bog east of Antioch, Lake Co., June 22, 1947, *G. D. Fuller 13008.* Common in Minnesota and has been found in Wisconsin and Michigan.

Duchesnea indica (Andr.) Focke.— Ravine near Golconda, Pope Co., April 13, 1946, *E. W. & G. B. Fell 4665;* and near Springfield, Sangamon Co., Sept. 5, 1948, *Lola Carter 14026.* Native of Eurasia.

Galium verum L.—Established in a weedy field, Elmhurst, Du Page Co., July 20, 1947, *Mrs. E. G. Goddard.* Naturalized from Europe.

Lappula deflexa (Wahlenb.) Garcke.—On dolomite ledges, moist wooded slope in Apple River Canyon, Jo Daviess Co., June 16, 1937, *F. J. Hermann* (UW).

Oenothera nuttallii Sweet.—McHenry, McHenry Co., June 15, 1925, *H. C. Benke 4041* (CM); and Belvidere, Boone Co., July 8, 1916, *H. C. Benke 1336* (CM). Adventive in Illinois; native of western North America.

Silene cserei Baumg.—Along railroad near Ringwood, McHenry Co., June 15, 1947, *G. D. Fuller 12912;* Fulton, Whiteside Co., June 25, 1948, *G. D. Fuller 13714,* and along Ry. in Belleville, St. Clair Co., July 7, 1948, *Julian Neill 1049.* Native of Eurasia.

II. ADDITIONAL LOCALITY-RECORDS OF ILLINOIS PLANTS

1. SPECIES NATIVE IN ILLINOIS

Acalypha ostryaefolia Ridd.—Reported by Fuller (1943) p. 95 for Sangamon Co.; by Mead (1846) p. 119; by Lapham (1857) p. 534; Patterson (1879) p. 37 (as *A. caroliniana*)—In Pere Marquette State Park, Jersey Co., August 10, 1940, *Fuller & Link 381;* roadside near Kincaid Mounds, Massac Co., July 29, 1939, *A. F. Whiting 1798;* and on rocky banks of Ohio River, Rosiclare, Hardin Co., Sept. 27, 1948, *G. S. Winterringer 1602* (UI).

Aronia prunifolia (Marsh.) Rehder.—Reported by Tehon (1942) p. 130—Rogers Park, Cook Co., September 9, 1898, *L. M. Umbach* (CM); sandy woods near S. Beloit, Winnebago Co., August 15, 1947, *E. W. & G. B. Fell 42710;* and June 26, 1948, *G. D. Fuller 13759.*

Bartonia virginica (L.) BSP.—Kankakee and Ogle counties, Fl. Ill., p. 205—Rocky branch, Clark Co., August 10, 1946, *E. L. Stover;* and bog near S. Beloit, Winnebago Co., August 14, 1947, *E. W. & G. B. Fell 47198.*

Chimaphila corymbosa Pursh.—Fl. Ill., p. 199; reported (as C. umbellata) by Patterson (1876) p. 26, Brendel (1887) p. 85, Higley & Raddin (1891) p. 75—Sandy soil in moist woods east of Roscoe, Winnebago Co., June 28, 1945, *E. W. Fell 45302.*

Heliotropium curassavicum L.—Reported by Patterson (1876) p. 31, Brendel (1887) p. 86, Huett (1897) 2: 165, Robinson & Fernald (1908) p. 680—Locally abundant in saline meadow on flood plain of Mississippi River near Dupo, St. Clair Co., August 17, 1947, *G. D. Fuller 13381;* and August 31, 1947, *J. Neill 1422.*

Medeola virginiana L.—Fl. Ill., p. 95, from Cook Co.—Moist woods near Ottawa, La Salle Co., May 20, 1939, *G. D. Fuller 808.*

Monotropa lanuginosa (Michx.) Nutt.—Fl. Ill., p. 199, from Cook Co.—Fox Ridge State Park, Coles Co., July 11, 1945, *G. D. Fuller 10623.*

Oenothera perennis L.—Reported (as *O. pumila* L.) Higley & Raddin (1891) p. 72; Pepoon (1927) p. 403—In low prairie near River Forest, Cook Co., June 28, 1943, *Gordon Pearsall 8342;* Sugar River bottom, Winnebago Co., June 23, 1945, *E. W. Fell 45269;* and near South Beloit, Winnebago Co., June 26, 1948, *G. D. Fuller.*

Pyrola secunda L.—Fl. Ill., p. 199, from Cook Co.—Moist sandy soil near Roscoe, Winnebago Co., July 10, 1946; and April 6, 1946, *G. D. Fuller 12129.*

Rubus odoratus L.—Reported by Tehon (1942) p. 106—Moist woods near Evanston, Cook Co., July 4, 1873, *Paul Blatchford 2530;* roadside thicket, Palisade State Park, Carroll Co., June 17, 1945, *G. D. Fuller 10525;* and moist woods, near Elgin, Kane Co., September 20, 1947, *G. D. Fuller 13222.*

Sanicula trifoliata Bickn.—Reported by Pepoon (1927) p. 410; Ries

(1929) p. 90; Fuller (1943) p. 96—Occasionally in moist woods, Dixon, Lee Co., September 4, 1942, *G. D. Fuller 3244;* Thornton, Cook Co., September 4, 1943, *G. D. Fuller 8142;* near Elgin, Kane Co., September 20, 1947, *G. D. Fuller 13206;* and in Tazewell Co., July 9, 1947, *V. H. Chase 8890.*

Solidago petiolaris Ait.—Lapham (1857) p. 518; Patterson (1876) p. 20; Brendel (1887) p. 85; Robinson & Fernald (1908) p. 888; Britton & Brown (1913) 3: 382; Rydberg (1932) p. 797; Friesner (1933) p. 42—Recently found on rocky bluffs of Illinois and Mississippi rivers. Starved Rock State Park, La Salle Co., September 13, 1939, *D. T. Ries 7559;* and near Dupo, St. Clair Co., October 4, 1947, *G. D. Fuller 13333.*

Spermolepis inermis (Nutt.) Math & Const.—Fl. Ill., p. 197—Reported from Peoria and Alexander counties and found in sandy fields near Rockford, Winnebago Co., July 8, 1940, *G. D. Fuller 2183;* and near Port Byron, Rock Island Co., June 24, 1948, *G. D. Fuller 13782.*

Thaspium trifoliatum (L.) Britt.—Fl. Ill., p. 197, as T. sylvaticum—This has been collected in 21 counties; the flowers are almost always yellow, rarely purple—Riverside, Cook Co., June 23, 1947, *F. A. Swink.*

Trientalis borealis Raf.—Fl. Ill., p. 201—Rosoce, Winnebago Co., June 28, 1945, *E. W. Fell 45301;* and west of Oregon, Ogle Co., June 28, 1946, *E. W. & G. B. Fell 46454.*

Veratrum woodii Robbins.—Fl. Ill., p. 93—Moist ravine in woods south of Charleston, Coles Co., September 6, 1946, *G. D. Fuller 12061.*

Verbesina occidentalis (L.) Walt.—Reported by Lapham (1857) p. 521, Patterson (1876) p. 23, as *V. siegesbeckia,* and by Britton & Brown (1913) 3: 488 as *Phaethusa occidentalis*—Open hillside forest, State Forest, Union Co., August 7, 1941, *G. D. Fuller & R. Fisher 796.*

Viola nephrophylla Greene.—Reported by Pepoon (1927) p. 393—Bogs on Waukegan Moors, Lake Co., June 8, 1917, *Millspaugh & Lansing 47;* near Waukegan, Lake Co., May 29, 1943, *G. D. Fuller 7761;* boggy swamp near Irene, Boone Co., May 25, 1946, *G. D. Fuller 12227;* and in shallow peaty bog 3 miles of South Beloit, Winnebago Co., May 26, 1948, *E. W. & G. B. Fell 4819.*

Viola pallens (Banks) Brainerd.—Fl. Ill., p. 187—Moist sandstone cliffs south of Oregon, Ogle Co., May 19, 1945, *G. D. Fuller 12046;* shallow bog near South Beloit, Winnebago Co., June 26, 1948, *G. D. Fuller 13761;* and in low prairie near Shirland, Winnebago Co., May 7, 1948, *E. W. & G. B. Fell 4819.*

2. SPECIES ADVENTIVE IN ILLINOIS

Amsinckia intermedia Fisch. & Mey.—Reported by Clute (1908) p. 56—Along railroad at Sycamore, De Kalb Co., June 5, 1945, *G. N. Jones 17253* (UI).

Cardiospermum halicacabum L.—Reported by Michaux (1803) Mead (1846) p. 60, Lapham (1857) p. 508; Schneck (1876) p. 524—On a roadside and in a wet field, climbing over fences and shrubs, well established on more than an acre of ground near Cahokia, St. Clair Co., August 17, 1947, *G. D. Fuller 12569;* and September 20, 1947, *Julian Neill 1365.*

Geranium sibiricum L.—Reported by A. Gray (1897) p. 360—Seward Bluffs, Winnebago Co., September 12, 1947, *E. W. & G. B. Fell 47283.*

Lythrum salicaria L.—Reported by McDougall (1936) p. 206—Olney, Richland, Co., July 21, 1917, *R. Ridgway 130;* near Glenview, Cook Co., August 4, 1926, *Macbride & Neuberth* (CM); and Rock River near Rockford, Winnebago Co., *E. W. & G. B. Fell 47271.*

Rubus laciniatus (West) Willd.—Fl. Ill., p. 152—Near a slag heap north of Freeburg, St. Clair Co., July 23, 1947, *Julian Neill 1163.*

Solanum elaeagnifolium Cav.—Reported by Huett (1898) 2: 165, Pepoon (1927) p. 453, McDougall (1936) p. 295—Abundant along railroad, well-established on the outskirts of Quincy, Adams Co., July 21, 1944, *R. R. Brinker.*

Torilis japonicus (Houtt.) DC.—Fl. Ill., p. 196—Roadsides near Edgemont, St. Clair Co., June 19, 1946, *Julian Neill 283;* East St. Louis, St. Clair Co., July 12, 1947; and near Thornton, Cook Co., July 24, 1948, *Floyd A. Swink 13900.* Naturalized from Europe.

Verbesina exauriculata (Robins. & Greenm.) Cockerell.—Reported (as *Ximinesia encelioides*) by Mead (1846) p. 119—Dry fields near East St. Louis, St. Clair Co., June 10, 1901, *G. W. Letterman* (CM), and August 24, 1946, *J. Neill 502.*

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Book Reviews

INTERNATIONAL RULES OF BOTANICAL NOMENCLATURE. Compiled from various sources by W. H. Camp, H. W. Rickett, and C. A. Weatherby. Chronica Botanica Co., Waltham, Mass., and Stechert-Hafner, Inc., New York City. 120 pp. 1948. $3.50.

Two years ago the April number of *Brittonia* consisted of the *International Rules of Botanical Nomenclature*, edited by Messrs. Camp, Rickett, and Weatherby. This was an outgrowth of a decision of the Council of the American Society of Plant Taxonomists in St. Louis in March 1946 to publish an unofficial special edition of the *Rules*. The present attractive and useful book is a second printing of this work, reproduced by offset. It appears opportunely at this time not only because copies of the official edition of the rules are no longer available, but also because the congress at Amsterdam in 1935 had made additional changes in the rules published earlier that year. These changes have not been readily available to American taxonomists, and appear in fact to have been altogether unknown to some botanists. The authors of the present edition emphasize that this 1947 text, although based upon authentic sources, is not to be considered as an official new edition of the rules, but instead is intended as a special unofficial edition issued as a service to members of the American Society of Plant Taxonomists and other interested persons.

As in the official 1935 edition published in Jena, the present book contains the rules of nomenclature as formulated by the international botanical congresses of Vienna, 1905, Brussels, 1910, and Cambridge, 1930, and in addition as previously noted, the revisions made by the congress at Amsterdam in 1935. The first part of the book sets forth the principles of botanical nomenclature arranged in 4 Chapters, 15 Sections, 74 Articles, many Recommendations, and numerous examples. Substitutions adopted by the Amsterdam Congress have been inserted in bold-face type, and official deletions from the third (1935) edition have been indicated by dots (. . . .). There are several appendices: one including regulations for determining types, one consisting of a list of conserved family names, one on nomenclature of garden plants, and another consisting of a list of conserved generic names (*nomina generica conservanda*), principally of vascular plants, but also including several pages of names of musci, lichens, fungi, bacteria, and flagellates. The conserved names are conveniently indicated in bold-face, with the rejected name or names in italics in a separate indented paragraph. This extensive appendix is provided with an index to the conserved and rejected names, a feature that was not included in the 1935 edition. There is also a good revised general index to the book.

Since it is now available at the low price of three dollars and fifty cents, this serviceable, strongly cloth-bound 120-page book should be within reach of all who may have occasion to use the information it contains. Students in advanced taxonomy can now use it as a class-room text. Not only taxonomic botanists, but biologists in general, and horticulturists, and all others interested in the plant sciences, will find much of interest and profit in this book. Perhaps publication in the present edition may serve to dispel some of the awe and mystery that has surrounded the difficult subject of biological nomenclature. This subject is so fundamental to precision in plant science that it should be removed from the realm of esoteric knowledge, especially in the non-taxonomic fields of research.

The publication of this book is most timely in connection with the preparations for the forthcoming Seventh International Botanical Congress to be held in Stockholm in 1950. The editors, Messrs. Camp, Rickett, and Weatherby deserve much credit for preparing this book, which conforms in all particulars to the usual high standards of book publication set by Dr. Frans Verdoorn of the Chronica Botanica Company.—GEORGE NEVILLE JONES, University of Illinois, Urbana.